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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.
ISSUED WEEKLY BY THE AMERICAN MACHINIST PRESS,
Vol. 22. 218 WILLIAM STREET, NEW YORK. No. 41.

Contents and Index to Advertisers, Page 12

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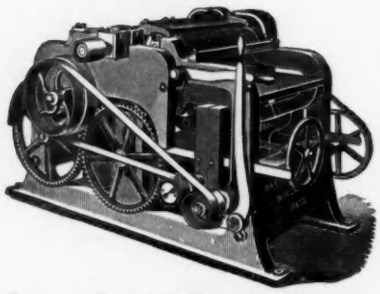

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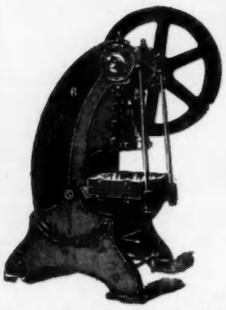

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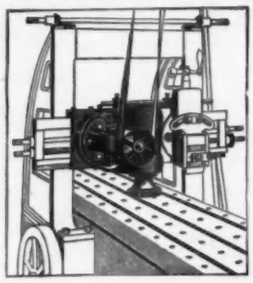

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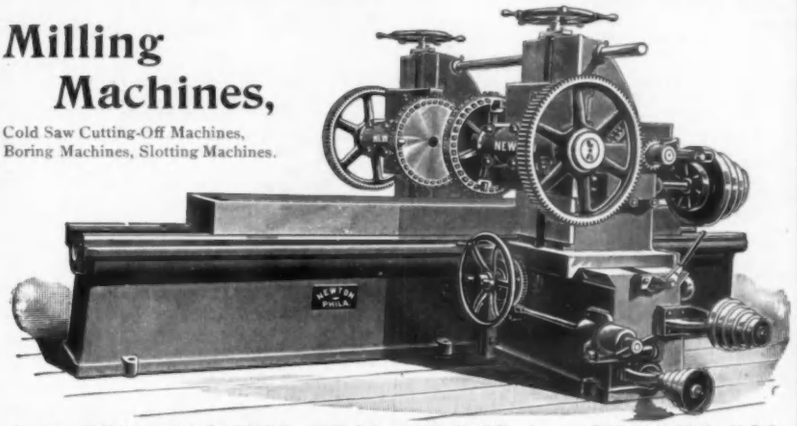

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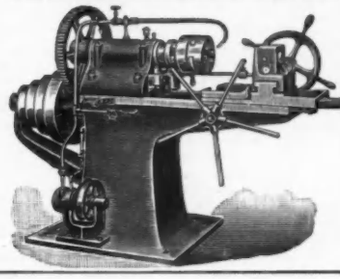

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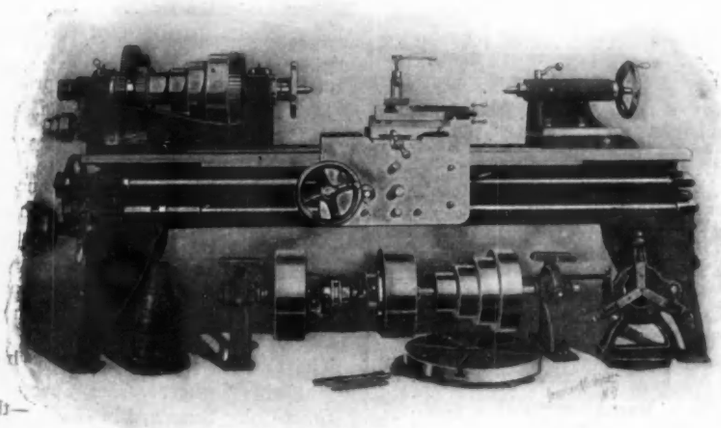

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AMERICAN MACHINIST

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A Department of Commerce and Manufactures.

A press dispatch announces that President McKinley favors the establishment of a Department of Commerce and Manufactures, its head to be a cabinet officer. This subject is now being agitated somewhat, and we believe the establishment of such a department would be a good thing. About ten years ago we suggested the establishment of a Department of Manufactures, and expressed our belief that its head should not only be a cabinet officer, but that he should have actual supervision of manufacturing operations carried on by the Government and should attend to all contracts with manufacturers. We still hold to that belief. We think that such a department should be in charge of a man experienced in conducting manufacturing business, and that all arms manufacturing shops, gun factories and industrial establishments of all kinds owned by the Government should be under the care of that department. We believe such a department could, if properly organized, do all the mechanical work now done separately by the Navy, War and Treasury Departments, and could carry on the work to much better advantage. We are convinced that it is nonsense to say that shoulder guns must be made by soldiers, battle-ships by sailors and mail-bags and postage stamps by postmasters. All these things are purely manufacturing operations, and should be carried on by or under the supervision of a department organized for that purpose. It is proper for our soldiers to specify what kind of a gun they want, or what its requirements must be; it is proper for naval men to specify what kind of vessels and armament they require, or what purpose they must serve and tests withstand, but beyond that the actual construction should be left to a department making a specialty of construction work.

We are aware that there is no precedent for this, and that European governments do not arrange things in that way, but we do a good many other things differently from what they do them, and here where we justly pride ourselves so much on our skill as mechanicians and constructors, there is no reason that is readily apparent why it would not be peculiarly appropriate for us to introduce this further innovation.

There would of course be strenuous opposition to it, especially within army and navy circles, but as a result of considerable reflection on the matter, we are convinced that it would be a decided improvement over the present system of having each department of the government manufacture to meet its own requirements. The change would put the government more nearly in line with the plan followed by private enterprises, and would remove many of the obstacles which now prevent government arms shops, navy yards, etc., from producing work as efficiently as private establishments do it.

The Methods and Charges on English and American Railroads.

"The Engineer" for September 15 has a long editorial in defense of English railways, their methods of carrying traffic and their charges therefor, as contrasted with American methods and charges, which deserves notice.

The article first compares the English carriage with the American car, the gist of its argument being that "the American system suits the American people and the English system suits the English people." Following this is the claim that, apart from personal and national taste, each system is best adapted to the surrounding conditions, and in proof of this it states that Americans in England choose the English first-class carriages in preference to the Pullmans when the latter are to be had. So far as the adaptability of each system to tastes and conditions is concerned, the case is a strong one, but the choice of English carriages by American tourists nevertheless proves nothing. To any sensible man the chief delight of travel in a foreign country comes from the insight obtained into the life and habits of its people, and it would be a queer American tourist, indeed, who would deliberately choose a familiar Pullman car when such a, to him, queer and characteristically British alternative as an English carriage was available. No doubt this wish to see how things are done by others is often prompted by a desire to superficially criticise and even to sneer at ways which, because they are strange, seem to the narrow minded to be absurd. All the same, even such an unworthy motive would all the more surely impel an American influenced by it to investigate the English carriage by trying it. To reverse the situation, suppose a few carriages of the English type were in use on our roads, would the editor of "The Engineer," if visiting here, select them in preference to such a, to him, odd and characteristic feature of our daily life as our usual type of cars? We think not.

It is, however, the remarks of our contemporary regarding railroad charges with which we have chiefly to deal. It is well known that these charges, especially for the transportation of freight, are much higher in England than here. "The Engineer" endeavors to make out a case against the management of the American roads in these words:

"It will surprise not a few to learn that hardly more than one-third of the railways in the United States pay any dividend whatever. The receipts barely balance the working expenses and the interest on mortgages. Very frequently they do not suffice even for the latter. The average return in the shape of dividends for the whole of the enormous capital invested in American railways amounts to barely 1.78 per cent. per annum. Now let it be borne in mind that an immense quantity of this capital came from Great Britain, and it is easy to see why rates are so low in the United States. If the methods of work-

ing were really so economical as we are told they are, there should be a dividend; and let it not be forgotten that the first cost per mile of the railways of the United States was probably not one-fourth of the first cost of the railways in this country."

The fundamental fallacy of this argument, which is a familiar one to Americans, lies in the assumption that the stock of American railways represents invested capital. Those who know the real facts know that it originally represented nothing but water. With some exceptions, which are so few as not to affect the argument as a whole, the roads were built with the proceeds of the bonds—the stock being practically given to the bondholders, or else held by the promoters without cost to them. That most of this stock should pay no dividends is thus quite as it should be. The bonds represent the real capitalization of the roads, and when the roads pay the interest on their bonds they pay substantially an equitable return on the real capital invested. It may be safely stated that, as a rule, where dividends are paid they represent an increased value of the roads through the growth of the country, and not a return on the original investment.

In many—perhaps most—cases the situation has been improved by the American practice of charging betterments to operating expenses instead of to capital account, as is done in England. To this extent the stock has come to represent real investment, though money invested in this way, after the success of an enterprise is assured, can scarcely claim equality of rights with that put out on a pure venture. It is a curious fact that American railroad management thus represents extreme wildcatting on the one hand and extreme conservatism on the other.

There is no doubt a real, though partial, explanation of the increased charges of English roads in the increased cost of those roads as compared with our own. At the same time much of that increased cost led to a capitalization far in excess of what was legitimate and which thus is, in one sense, water. We refer to the enormous "parliamentary expenses," which, necessary though they were, nevertheless increased the capitalization far beyond what it should have been, and now constitute a burden on the roads and on the public. In a rough and ready way the bonds and the stock of American roads represent the real and the fictitious original capital invested, and the laws of trade and competition have here resulted in substantial justice between the public and the roads. No such solution is possible in England, and, so far as can be seen, the burden of excessive capitalization of English railways is permanent. At the same time this great capitalization has been and is constantly being still further increased by the universal English practice of charging all betterments to capital account and the difference in the practice of the two countries in this respect puts another difficulty in the way of a fair comparison of freight rates.

If "The Engineer" desires to justify the heavier charges of British roads it should look to the service. While those roads charge more than ours they give more. The system of delivery to the consignee which prevails in England is not followed here, where delivery invariably means delivery at the railroad station, with additional charges for demurrage if the goods are not promptly removed by the consignee. English goods service is, in fact, more like our own express service than our freight service. There can be no doubt that the American people have unduly plumed themselves on the cheapness of their freight service, and that English critics of English roads have been unfair in their comparisons because of ignorance of this fundamental feature of the two services. In addition to these considerations is that of length of haul as related to terminal charges. As the haul increases in length the percentage of terminal charges goes down, and a comparison on the simple ton-mile basis, without regard to length of haul, is necessarily unfair to the short haul. The enormous distances of this country are, of course, unknown in England, and this fact renders idle any comparison of the rates charged in the two countries on the ton-mile basis.

The conditions of the traffic and the services rendered in the two countries are so different that an exact comparison is almost, if not quite, impossible, but this is no reason why the conditions which prevail in the two countries should not be stated and understood. "The American system suits the American people and the English system suits the English people," and that is about as far as we expect to see the analysis carried with success.

The Seventy-Fifth Anniversary of the Franklin Institute — John Fritz and the Three-High Roll—Charles Kirchoff on Three-Quarters of a Century of Progress.

The Franklin Institute of Philadelphia is holding a series of meetings in commemoration of its seventy-fifth anniversary, the third of these occurring on October 4 at the Exposition Buildings. Mr. James Christie, chief engineer of the Pencoyd Iron Works, who presided, made a brief address introducing Mr. John Fritz, known world wide as the inventor of the "three-high" roll mill, which Mr. Christie said was the most revolutionary mechanical improvement in the manufacture of iron which had ever been made. The address of Mr. Fritz was largely historical or reminiscent. The improvement in rolling mills began in 1841 with the manufacture of rails. In 1857 the three-high roll was introduced by Mr. E. Y. Townsend, of the Cambria Iron Works, at the earnest solicitation of Mr. Fritz. Great opposition was encountered, failure was predicted, and Mr. Fritz was appealed to by his friends to abandon the project, but he felt that it was the only thing that could save the company. He described the building of the machinery, the remodeling of the mill and the test when it was started up. The first pile went through without a hitch, finally emerging a perfect rail, making a great financial success for the Cambria Iron Company and revolutionizing rail-making practice. Mr. Charles Kirchoff, editor of "The Iron Age," followed Mr. Fritz with a valuable address on "Three-quarters of a Century's Progress in Mining and Metallurgy." Statistics of production, he said, only partly reflect the development of an industry. Practically, seventy-five years ago our greatest mining and metallurgical industries were in their infancy. The principal agencies in their growth and development were successively mentioned. The most striking progress had been in the work of excavation. The first percussion drill was patented in 1849. Compressed air was suggested for use in 1852, but was not a practical success until 1862. Then came the high explosives. Pumping and hoisting machinery was much improved and underground traction was developed. Coal-cutting machinery is now being rapidly introduced. A splendid achievement in mining is the handling of auriferous sand by hydraulic apparatus. This began about 1853. Thorough work has been done in the magnetic separation of iron ores. Marked progress has been made also in the metallurgy of the precious metals, especially during the present decade. In conclusion the speaker said:

"It was the key-note of Franklin's life that all his thoughts and all his endeavors were directed to making his work of benefit to the human race. Although those who have labored in our fields may not have done so as consciously or as deliberately as he, the fact is that progress in mining and metallurgy has powerfully contributed toward that end."

An Evening School of Electricity.

The Educational Department of the Harlem (New York) branch Young Men's Christian Association, at No. 5 West 125th street, has added to its curriculum a course in electricity. The school will be in charge of Mr. William J. Clarke, who has seen active service in nearly every branch of electrical work.

The sessions will be held on Tuesday and Friday evenings, commencing October 17, and the course will consist of forty-eight lectures, covering first the fundamental rules and principles of electrical engineering, and following this with telegraphy, telephony, police and fire alarm telegraph, arc lighting, alternating current apparatus, the distribution of electric power, the electric street railway, the elec-

tric automobile, the "X" rays and wireless telegraphy. The lectures will be illustrated by a stereopticon, and a large amount of apparatus will also be used. At the close of each lecture the members of the class will be permitted to ask questions. The cost of the course is placed at $10, including limited membership in the branch for one year.

Commercial Review.

NEW YORK, FRIDAY EVENING, October 6.

MACHINE TOOL MATTERS.

An important aspect of the present situation in machine tools is the extent to which the market is in the control of selling houses. Attention to this is called by a man who has pretty good opportunities for observation. He points out that jobbing houses have bought out various manufacturers' stocks for many months ahead, so that while the manufacturer is all tied up with orders and unable to attend to new customers, the dealer is able to offer quick deliveries on the same tools, which he does at a premium of from 10 to 25 per cent. above regular prices. To substantiate this view an instance is cited in which a manufacturer required about a year for the delievery of a certain tool, but the same was secured from a middleman on a month's time. While it is not a fact that dealers have the situation by any means perfectly in hand, their stocks being low in many cases and their embarrassment in getting orders filled often being great, still there are probably some of them who are making a very good thing for themselves out of the stringency of the market in the way indicated.

If there is one tool that is becoming as rare as the proverbial hen's teeth, it is the planer. This is apparently because a planer is, in average cases, a large tool and takes long to build. A year and a half ago lathes of medium large size were a scarce article, because of their requirement in projectile manufacture, but what they were last year is nothing to what the planers are this year. Planers of inferior make are not so difficult to obtain now as those of better quality, but the same may be said of other tools. We know a man who lately had a 48-inch planer for sale to be delivered in two or three weeks, which in these days means practically immediate delivery. It was made by a company which does not like to sell tools to jobbers, and consequently refuses to give them a discount below the regular rates to consumers, and whether that dealer paid full price for the tool we do not know, but anyway he had it for sale. This planer proved a center of attraction equal to a pretty girl with a fortune, for in three days a dozen offers were received. It was sold at an advance of 25 per cent. above the present ruling high price.

An authority upon machine tool export trade pronounces the market in some foreign quarters to possess hardly as sharp an edge now as in the early part of the year. In Austria-Hungary, for instance, business conditions generally are depressed, owing to political disturbances. He takes issue with Mr. Kirschbaum upon the view quoted from the latter in a recent number of the "American Machinist" that German dealers are overstocked with the more easily obtainable lines of American tools. He does not believe this condition to be general with German dealers, although it may exist in specific cases, and points out that they would purchase with caution in the present times of large values.

The authority referred to remarks further that American manufacturers are fully awake to the wisdom of holding foreign trade, and he does not think that they will raise prices materially beyond the point to which they have already ascended. A further increase, he thinks, would have a sharply disastrous effect.

The Central Railroad of New Jersey has long had in contemplation to erect and equip a new machine shop at Elizabethport, N. J. It is understood that plans have been drawn up for the building, which will be located nearer the railroad station than the old one, but specifications for the machine tools are not yet given out.

The readiness with which an attractive machinery appliance finds a market in these days is illustrated in the case of a new lathe center grinder, the "Simplex," recently put upon the market by J. W. Cregar, Philadelphia. By the time it had been out sixty days 167 had been disposed of, the purchasers including William Sellers & Co., Bement, Miles & Co., The Philadelphia Engineering Works, navy yards, etc.

DYNAMOS AND MOTORS.

The electrical manufacturing companies have gradually been increasing their facilities by putting on new men and, in some cases, they have thereby gained upon orders so as to be able to handle business a little more satisfactorily, but in other instances there is no appreciable relief. The trouble in obtaining steel castings is without mitigation. One company complains that its stock in this line has been reduced by more than one-half in thirty days. An order for castings which it has had outstanding for five months is yet unfilled. The same company notes a difficulty in obtaining copper materials, but this last feature seems not to be universal. It is almost needless to say that the heavy demand for electrical machinery is yet unabated. In fact, the market seems to be more excited now than it has been at any time in the past.

More than a score of companies which manufacture dynamos were represented at a meeting held in Chicago last month to take measures that should lead to the adjustment of prices to a basis compensatory for the advances in raw materials. The open initiative was taken by officials of the Cutter-Hammer Manufacturing Company, of Chicago. Mr. Campbell Scott, of the C & C Electric Company, presided, and is chairman of a committee which will arrange for a definite organization to accomplish the end in view.

As Mr. Scott explains matters to a representative of the "American Machinist," while demand for electrical machinery is phenomenally heavy, the manufacturers are, to a great extent, failing to obtain adequate margins of profit, because the advances in raw materials have not been compensated for upon the finished products. Such advances on electrical machinery as have been made have been far from uniform among the different companies, and some of these do not hold to their nominal rates when it comes to bidding on contracts.

This movement toward a mutual understanding upon values embraces a good many strong concerns, yet not the very largest, for the General Electric and Westinghouse electric companies are not represented in it. The General Electric Company is now endeavoring to avoid an increase of prices beyond what it has made already.

At the first of this month the Bullock Electric Manufacturing Company advanced prices 10 per cent. and the Eddy Electric Manufacturing Company made a still greater increase. "We prefer to take less work at a broader margin than we have been receiving," explains the representative of the latter. "With an equality in total profits there is less inconvenience where the prices are good."

Since the beginning of autumn the General Electric Company has radically increased the number of men at work in its shops on night turn. The night force is now about one-half as large as the day force. The total number of employees at the Schenectady and Lynn shops is estimated, off-hand, by an official of the company at 15,000.

The General Electric Company has received an order for three 800 to 850 kilowatt generators and 110 car equipments for the Havana City Railway.

The Eddy Electric Manufacturing Company has refitted a small building appurtenant to its factory as a department especially for carriage motors.

The Bronson & Weston Lumber Company, Ltd., Ottawa, Canada, has purchased 250 horse-power of C & C iron-clad dust-proof motors. The C & C Electric Company is getting many orders from England. This week they have sold for shipment to that country more than twenty machines, aggregating over 150 horse-power. The company is making many sales also through its agency at Buenos Ayres, which was established about two months ago.

MACHINERY EXPORTS FOR AUGUST.

The "Monthly Summary of Commerce and Finance," compiled by the Bureau of Statistics, Treasury Department, shows exports of American made metal working machinery amounting for August, 1899, to $635,549, against $573,215 for August, 1898. For July, 1899, the amount has already been reported at $532,485. For the eight months ending August, 1899, the total was $4,495,665, and for the eight months ending August, 1898, $3,552,110.

Electrical machinery exports were: August, 1899, $230,009; August, 1898, $143,151; July, 1899, $250,462; eight months ending August, 1899, $1,828,048; eight months ending August, 1898, $1,439,743.

Printing presses and parts thereof: August, 1899, $78,945; August, 1898, $38,777; July, 1899, $60,137; eight months ending August, 1899, $597,894; eight months ending August, 1898, $528,755.

Pumps and pumping machinery: August, 1899, $326,360; August, 1898, $194,273; July, 1899, $247,296; eight months ending August, 1899, $2,051,199; eight months ending August, 1898, $1,428,029.

Locomotive engines: August, 1899, 107 in number, valued at $1,412,432; August, 1898, 59, at $649,322; July, 1899, 16, at $122,068; eight months ending August, 1899, 366, at $3,636,792; eight months ending August, 1898, 424, at $3,844,917.

Stationary engines: August, 1899, 109 in number, valued at $60,620; August, 1898, 39, at $20,187; July, 1899, 79, at $48,829; eight months ending August, 1899, 547, at $304,107; eight months ending August, 1898, 358, at $258,274.

Boilers and parts of engines: August, 1899, $243,518; August, 1898, $123,572; July, 1899, $157,355; eight months ending August, 1899, $907,136; eight months ending August, 1898, $749,063.

PITTSBURGH REPORT.

There is a tendency to hold back in many lines of the iron and steel trade, and this is having some little influence on the market. Buyers in general are not placing their money in such large piles in order to get material as they did a month or two ago. They are perfectly willing to wait, and this delay seems certain to extend into the coming year. Nearly all furnaces have sold their output up until July next, and the producers are now somewhat indifferent as to taking business for the early part of next year. Small sized lots of Bessemer iron were sold in Pittsburgh last week for $25 per ton, for immediate delivery.

Machinery manufacturers have their hands full. In fact, a leading rolling mill machinery builder informed the correspondent that several large contracts were refused for the simple reason that the manufacturers could not touch the work for some months to come. The Frank-Kneeland Machine Company is rushed with work, as is also the A. Garrison Foundry Company. The Mesta Machine Company will occupy its new Homestead works early this month, and will begin the manufacture of machine-molded gears made from cast steel, pumping machinery, etc. The new works are fully equipped with all labor-saving devices, and constitute a most modern plant in every respect.

The Pennsylvania Malleable Iron Company has awarded contracts for the equipment of its new works at McKees Rocks, near Pittsburgh. The steel buildings will be erected by the Pittsburgh Bridge Company. It is understood that the company is still in the market for conveying machinery.

The Pittsburgh Steel Shafting Company, organized by C. W. Fitch, Jr., and others, of Braddock, has its plant almost completed. The power equipment is being furnished by the Atlas Engine Works, Indianapolis, Ind., while the drawing machinery will be installed by the Brightman Manufacturing Company, Millersburg, O.

CHICAGO MACHINERY MARKET.

Less is heard these days among machinery men about the running of shops and factories overtime, or particularly night and day, as was common six months ago. Occasionally a shop is encountered, the trade of which compels this extra exertion, but they have become the exception. But no plant, save under unusual circumstances, where evolutionary forces are at work, can be found that is not busy. A number of bicycle factories in the West are in a transitory stage, and their future cannot be predicted. Some have gone into other lines of manufacture. Thus, the Stover Bicycle Works, of Sterling, Ill., have been transformed into a plant for the manufacture of gas and gasoline engines. The Indiana Bicycle Company, of Indianapolis, Ind., has taken to the manufacture of motors. The Bradley Manufacturing Company of this city is said to have in view the change of its bicycle department into some other branch of manufacture. It is difficult to determine the resultant of the various forces active in the bicycle industry, and everyone seems to be very much at sea respecting the trade, as viewed from the machinery standpoint. The revival in the sale of bicycle machinery so far this season has scarcely been appreciable.

Manufacturers of building hardware are among the very busy workers in iron and steel. They have had a most prosperous season, and the coming year is equally rosy in prospect. The large stove manufacturers are nearing the close of one of their busiest seasons in history. Manufacturers of hardware specialties are, as a rule, as busy as the limits of their capacity will permit. And looking over the entire field, there is not a little shifting of manufacture from one line of goods to another. More commonly there is the extension of a plant to additional varieties of output.

All this is grist for the machinery men and for the machinists' supplies trade. Comparing aggregates, the latter shows little change from that of a month ago. It is a good steady business, without any features that approach the phenomenal, or even unusual. Manufacturers of brass beds and similar goods are unusually busy, and the makers of holiday goods are increasing speed in anticipation of a wonderful season opening to them.

The price of cold rolled shafting has taken another sharp upturn. Stocks are greatly depleted. For all kinds of power transmission machinery the demand keeps well ahead of the producing capacity and the trade is decidedly buoyant. The advance in the price of files has had one curious effect. For several years files had been selling so low that it did not pay to have them recut. But now almost every large consumer in this territory has recommenced the recutting of his old files, and the shops here that are devoted to that trade are doing a big business.

Quotations.

NEW YORK, Monday, October 9.

Iron — American Pig, tidewater delivery in 1900:—

Pennsylvania Irons:	
No. 1 X foundry	$23 60 @ $24 00
No. 2 X foundry	22 60 @ 23 00
No. 2 plain	21 60 @ 22 00
Alabama Irons:	
No. 1 foundry	22 75 @ 23 50
No. 2 foundry	21 75 @ 22 50
No. 3 foundry	21 00 @ 21 50
No. 1 soft	22 75 @ 23 25
No. 2 soft	21 75 @ 22 25
Foundry forge	20 25 @ 20 75

The market is very irregular, and some furnaces ask more than the above prices.

Bar Iron — Base sizes — Refined, mill price on dock, 2.20 @ 2.35c.; store price, 2.60c., upward; common from store, 2.50 @ 2.60c.

Tool Steel—Base sizes, Standard quality, 7 @ 8c.; extra grades, 12 @ 14c.; special grades, 16c. and upward.

Machinery Steel—Base sizes—Ordinary brands from store, in small lots, 3.00 @ 3.25c.

Cold Rolled Steel Shafting—Base sizes —From store, in small lots, 4 @ 4.25c.

Copper—Carload lots, Lake Superior ingot, 18¼ @ 18½c.; electrolytic, 17¼ @ 17¾c.; casting copper, 17⅛ @ 17½c.

Pig Lead—Carloads, 4.62½ @ 4.65c.; wholesale lots, 4.60c.

Pig Tin—In 5 and 10-ton lots, f. o. b., New York, 32½c.

Spelter—Prime Western in carload lots, 5½ @ 5⅝c.

Antimony—In cask lots or over, Cookson's, 11 @ 11¼c.; Hallett's, 9⅞c.

Lard Oil—Prime city, present make, ice-pressed, 45 @ 47c., according to brand and quantity in lots from one barrel upward.

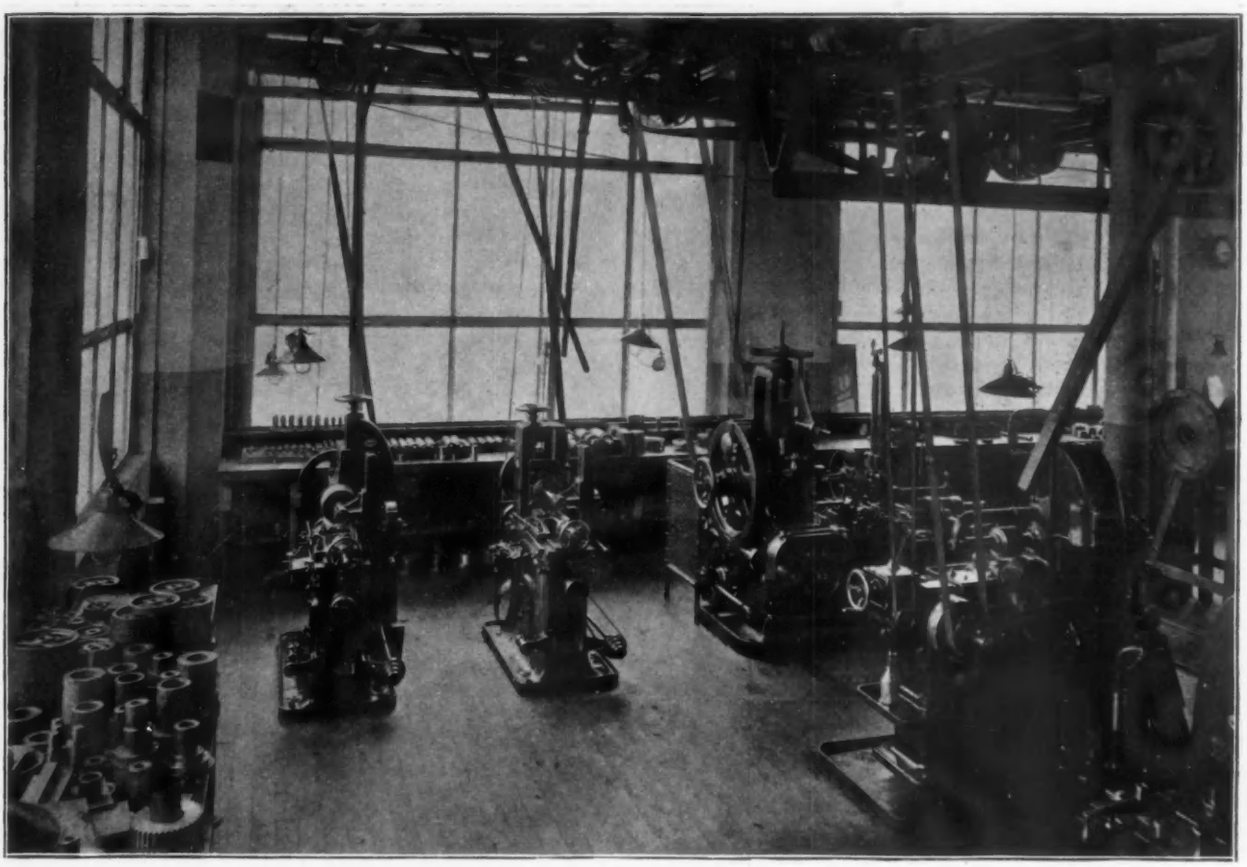


FIG. 15. GEAR CUTTERS. CORNER OF GEAR-CUTTING ROOM.

FIG. 16. AUTOMATIC SCREW MACHINES.

The New Work Shops of Ludw. Loewe & Co., in Berlin—III.

THE MACHINE SHOP—CONTINUED.

In the south wing, second floor, of the machine shop is the gear-cutting department, which is equipped with American automatic gear cutters for spur gears and with machines of the Warren pattern, built by this company, for bevels. There are also automatic rack-cutting machines, worm gear cutters, testing machines, etc.

On the third, or top, floor of this building, and occupying the south and middle wings, and the connecting portion as well, is the screw-machine department, in which are many automatic as well as hand machines, and on this floor is also the counter-shaft and pulley department.

Nearly all of the departments that have been mentioned have their separate tool rooms, in which all tools and fixtures belonging to the department are kept and looked after, and which are checked out to the workmen.

The ceilings of this building, and in fact of all the others as well, are so arranged that all hangers required for the various transmission machinery can be clamped in place with very little work, and entirely without drilling for bolts. To this end the main floor I-beams have been left exposed underneath so that steel I-beam stringers can be laid on top of their lower flanges. These stringers are held in place by clamping strips only, which clamping strips are tightened by bolts. This permits the stringers to be readily put in

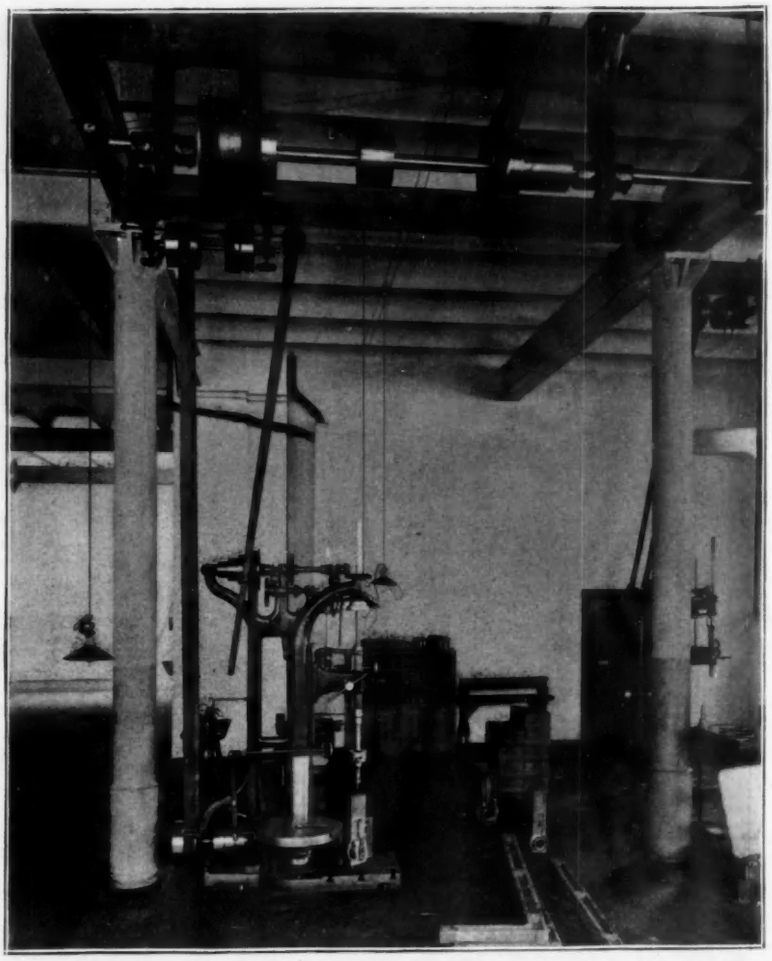
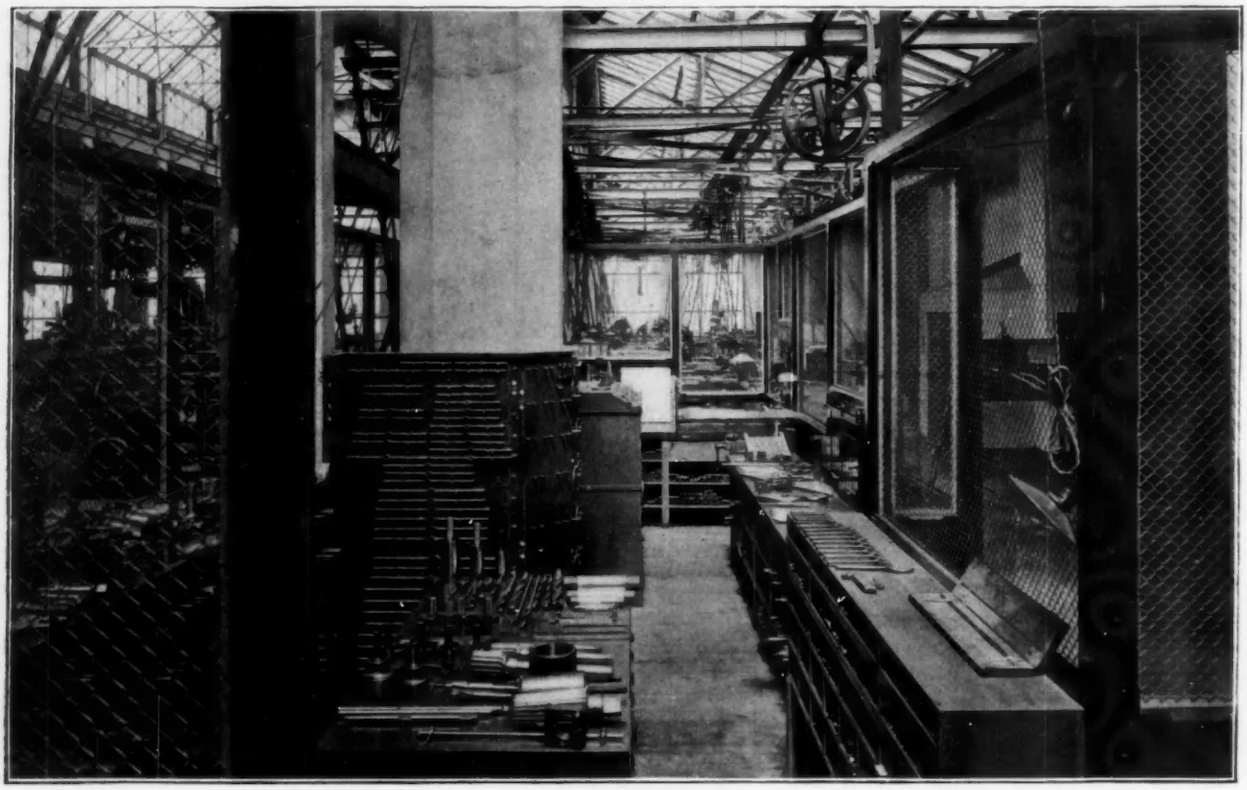


FIG. 17. SHOWING METHOD OF FASTENING COUNTERSHAFT AND MAIN SHAFT HANGERS.



TOOL ROOM, MACHINE HALL.

wherever they may be required, and as readily shifted when there is need for doing so, and to these stringers the shaft-hangers are secured in much the same way. The construction will be readily understood from Figs. 17 and 18. This construction is also well adapted to the support of girders for air hoists, which are arranged at points where heavier parts of machines are to be handled, as shown in Fig. 19.

The floors throughout consist first of sleepers, which are bedded in cement, and to these are nailed pine planks 2 inches thick, tongued and grooved. These are covered with ⅞-inch hard American maple, making a floor which experience has shown to be durable, comfortable, easily kept clean, and which permits machinery to be secured to it without special preparation. Supported as it is, it is expected to remain true and to form an excellent support for machine tools, although the heavier machines are, of course, supported upon special foundations put in for them on the ground floor.

The windows consist of iron frames, which are set with ribbed glass, and where

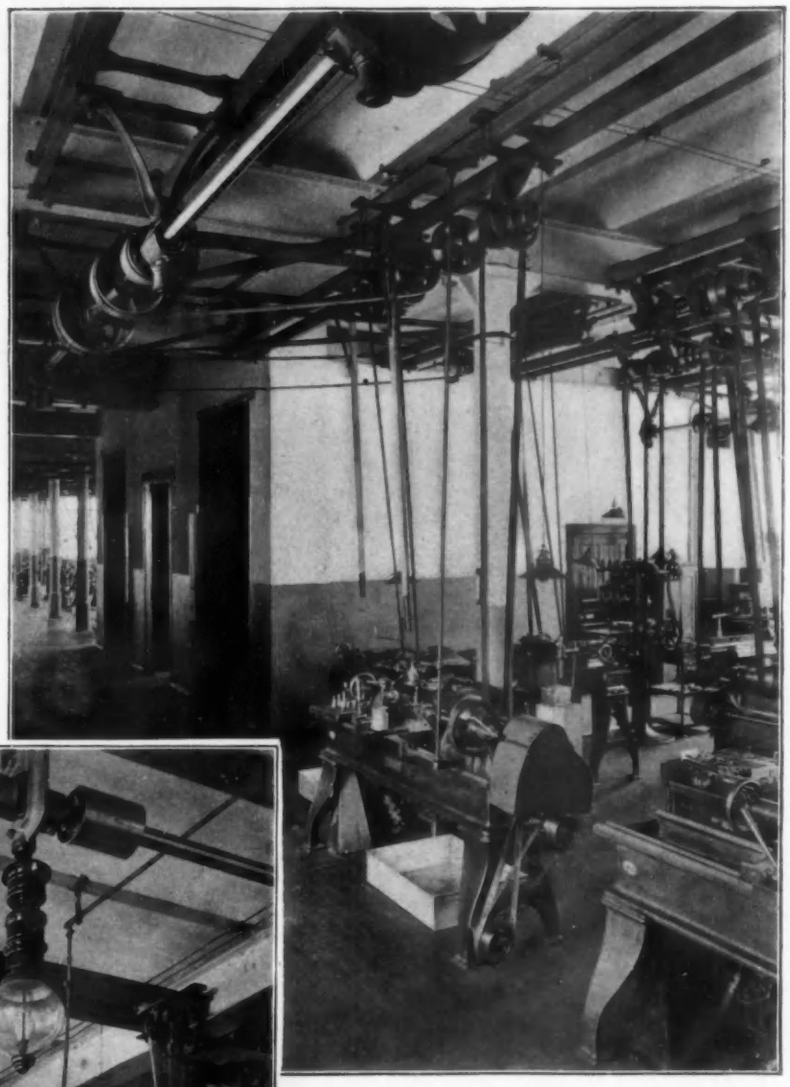


FIG. 18. SHOWING METHOD OF FASTENING COUNTER-SHAFT AND MAIN SHAFT HANGERS.

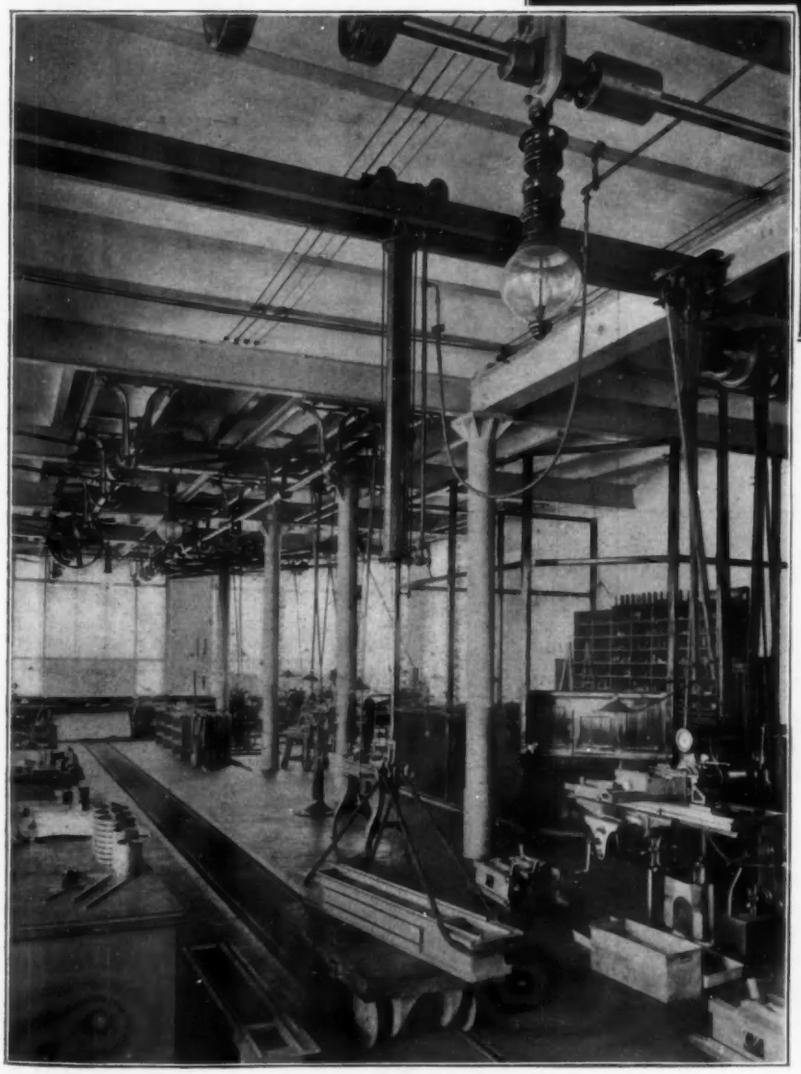


FIG. 19. PNEUMATIC HOIST.

it has been desirable to provide for openings this has been done by means of sliding sash. Not so many openings are needed, however, as would be otherwise required were it not for the fact that the forced blast system of heating is used in summer time to maintain a circulation of cool air in all parts of the building, the apparatus for this being placed in the basement.

The ribbed glass referred to is believed to have many advantages for shop windows. It admits light freely, but prevents vision either from the outside or inside, and the light is thoroughly diffused, no direct sunlight falling upon any workman or his work, and no strong shadows being formed. It will be noticed by reference to Fig. 8 that the brickwork above the windows is beveled off at such an angle as to offer no obstruction to the light, and it will be noticed also that the windows occupy a very unusual proportion of the side walls of the building, the

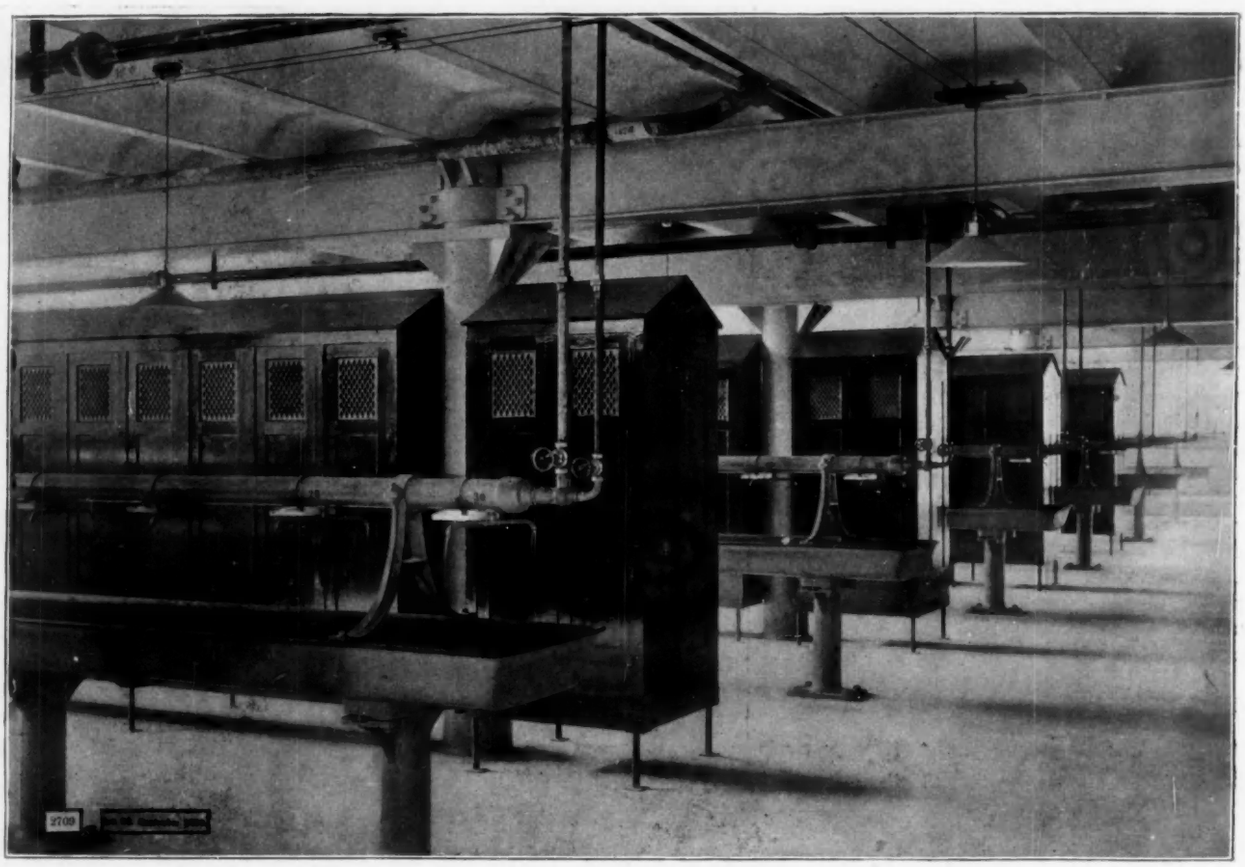


FIG. 20. WASH-ROOM AND WARDROBES FOR WORKMEN.

photographs indicating the splendid lighting which results from this feature.

Nearly the entire basement of the machine shop is occupied by the wash-rooms and clothes closets for the men. Fig. 20 shows the arrangement of these, and it will be noticed that each man has his own numbered place in which to wash, where he keeps his own soap, and that he may finish his ablutions in a running stream of clear water. Adjacent to each man's station is his private clothes closet, which is a well-made affair and thoroughly ventilated, as clothes closets should always be.

All workmen enter and leave the shops through these wash-rooms, which are kept locked during working hours, and are in charge of a man whose duty it is to see that the place is kept neat and clean.

The arrangement of the working time which prevails in America has been adopted instead of that which is usually followed in Germany; that is, the men go to work at 7 A. M., stop at 11.45, go to work at 1 P. M. and stop at 6. This makes 9¾ hours' labor, for which they receive 10 hours' pay, the extra time being given in which to "wash up;" this being, in fact, a step in advance of the usual American practice. No time is checked at the main gates, but instead there is in each department a time recording apparatus, so that a workman must be within his own department when the clock makes a record of his time.

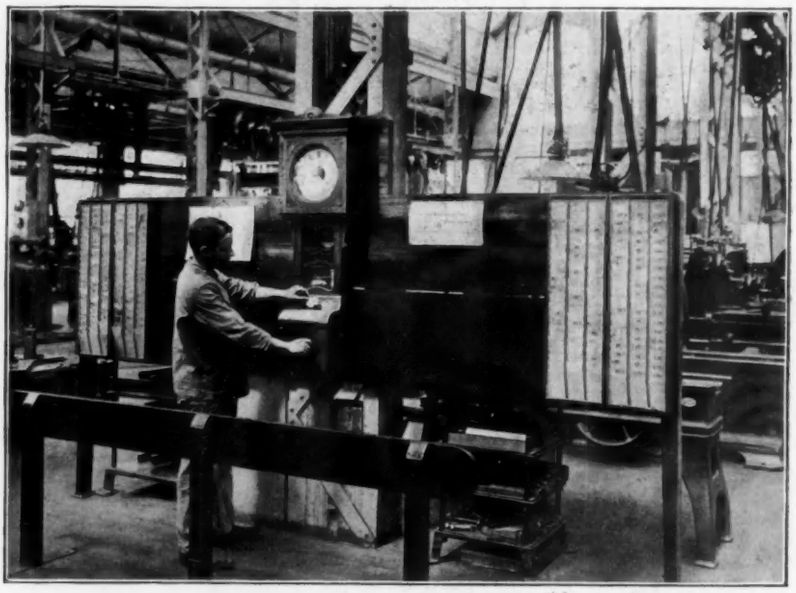


FIG. 21. TIME RECORDER.

At Figs. 22 and 23 are shown some features, the advantages of which will be recognized by shop men readily enough, and which show the care that has been taken to have everything in the neatest and most convenient shape for carrying on the work in the most efficient manner.

(To be Concluded Next Week.)

A New Trade.

Mrs. Finnegan—"Bedad, yer hoosbind drisses as iv he wor a flure-walker er a banker! Phwere is he wur-rkin'?"

Mrs. Flannagan—"Sure, he's got an iligant job in a horseless livery stable, fadin' air t' them hobo-mobo troocks!"

The Gasoline Engine in Boats—I.

BY HERBERT L. TOWLE.

The engine power that can be put into a steam launch is limited only by the weight permissible on a given displacement, and an up-to-date outfit for, say, a 30-foot hull will not improbably develop 20 horse-power at the screw. In the gasoline launch, on the contrary, the weight of the engine is quite a secondary consideration, and the restriction here is in the vibration, which much exceeds that of the steam engine, and must be kept within bounds before power or speed can be thought of.

Pursuing the comparison, the 30-foot hull supposed above will be of about 6½ feet beam, with rather full lines. The steam engine will probably be a 3½ and 7 by 7-inch compound, running 375 revolutions, and the weight of engine, boiler and fittings, with water ready for steaming, will be from 2,000 to 2,500 pounds. A gasoline launch of the same length and beam will have a shallower draft and finer lines, and will carry a 6 by 7-inch two-cylinder engine, running 340 to 400 revolutions, and weighing, with flywheel, reversing gear and pumps, from 650 to 700 pounds. The engines are comparable

FIG. 22. BOLT RACK.

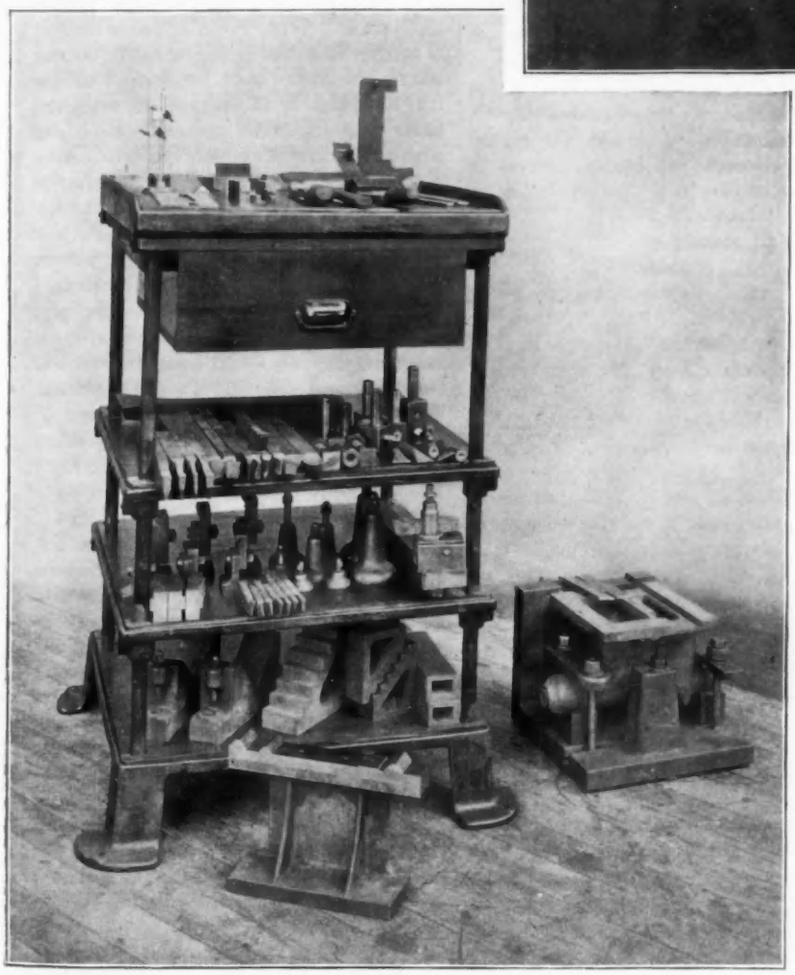


FIG. 23. WORKSHOP STAND WITH PLANER TOOLS.

as to size, the somewhat greater mechanical vibration of the steam engine being readily absorbed by the boiler's mass; but while the former is good for 20 horse-power, the gas engine will develop only 6½ to 8, and the launch which carries it will make, at best, 8½ miles an hour, against its rival's 12. Indeed, so well is it recognized that stroke dimensions, and not weight, constitute the limiting factor in gasoline power, that many builders put more metal into their designs than is necessary for strength alone, for the sole object of absorbing the vibration; and without exception they address themselves to the class which prefers comfort, economy and roominess at the sacrifice of speed, and decry "racing machines" as a matter of business policy.

This, however, can hardly be regarded as the crowning destiny of the gas engine. The "cranks" who now hold it in contempt, with many another for whom the drawbacks of coal dust and government inspection are too severe, would transfer their allegiance quickly enough if a gasoline motor could be found to rival the speed of steam.

But is this possible?

A partial answer is to be found in the rapidly growing army of small, lightweight, very high speed motors for vehicle use, which develop a horse-power on 50 pounds weight or less, and are rapidly

revolutionizing designers' notions as to the limit of speed practicable for these machines. The question is inevitable: If this can be done with cylinders 4 inches in diameter, why can it not be done in diameters of 6, 7 and 8 inches, and with slightly longer strokes? With reservations, it can. It is of doubtful expediency to attempt to pare the weight of a launch motor as low as that for a carriage, for while the speed of the latter varies from minute to minute, that of the former is at a maximum nine-tenths of the time; and a break-down afloat, with a rising sea and the boat drifting on a lee shore, is quite another matter from, let us say, a broken axle, when a new one can be wired for and received by express the next day. In the matter of speeds, however, and of balancing, the launch builder can with profit take a lesson from his brother of the horseless carriage.

The problem for the launch builder may be stated thus: With given cylinder diameter and stroke, the greatest that can be permitted in a given hull, what arrangement of cylinders and what design as regards speed and moving parts will give the greatest power, within due limits of weight and cost and without greater vibration than attends the use of two of these same cylinders? If larger diameter means more vibration—other things being equal—so does higher speed, and there are severely practical limits to the multiplication of cylinders. In motor carriages the usual solution is to place the cylinders on opposite sides of the shaft, and as nearly in line as may be, with cranks 180° apart. This gives a practically perfect balance, but it is obviously unsuited for boats. Since this way is barred, it will be worth while, even at the risk of seeming elementary, to review in detail the various factors producing vibration.

To begin with, each crank, unless balanced by a weight opposite and in the same plane, will exert its own centrifugal force; and the same is true of the crank pins and lower ends of the connecting rods, save that these may be balanced by weights equally divided between the adjacent cranks. Without balance weights, therefore, the shaft, even if in standing balance as with cranks "opposite" or 180° apart, is not in running balance, and will exert a slewing tendency. Again, each piston, with the wrist-pin and upper end of the connecting rod attached, exerts by reason of its inertia a pull or jerk, upwards at the top of its stroke and downwards at the bottom, and owing to the angularity of the connecting rod the upward jerk is materially greater than the downward. Consequently the bed of a "cranks opposite" engine receives from these parts a complex vibration, a fore-and-aft rocking or see-sawing, combined at the end of each stroke with an unbalanced upward jerk. This upward jerk is a feature of the two-cylinder marine engine, and is one which no balancing will remedy.

Of the above two sources of vibration, the former may be dismissed with the remark that any engine in which vibration is to be reduced to a minimum will have balanced cranks as a matter of course. As to the latter, the inertia of the reciprocating parts, in pounds pull, may be calculated for any position of the crank from the formula given on page 31 of the "American Machinist" for October 27, 1898, and here repeated. It is especially useful for ascertaining the inertia at the top and bottom centers.

$$F = F_0 \left(\cos. w + \frac{R}{L} \cos. 2w\right)$$

in which

F = inertia force required.

F_0 = centrifugal force of reciprocating parts if concentrated at crank-pin.

w = crank angle measured from top center.

$\frac{R}{L} = \frac{\text{length of crank}}{\text{length of connecting rod}}$, which for marine engines may be taken as ¼.

F_0 is determined by the general formula for centrifugal force:

$$F_0 = \frac{WV^2}{gR}$$

in which

W = weight of body in pounds.

V = velocity of same in feet per second.

g = acceleration due to gravity = 32.2.

R = radius of revolution in feet, or, in this case, the length of crank.

For illustration let us take the typical 6x7-inch two-cylinder engine. Here W will be about 28 pounds for one cylinder, distributed about as follows:

Piston—22 pounds.

Wrist-pin—1.5 pounds.

Upper end of connecting rod—4.5 pounds.

If we assume 340 revolutions per minute, with a good mixture and fair compression, the engine will develop 6½ to 7 horse-power. At this speed $F_0 = 321$ pounds. At the top center $w = 0$, and $F = 1.25 \times F_0 = 401$ pounds. At the bottom center $w = 180°$, and $F = -.75 \times F_0 = -241$ pounds. There is, therefore, an unbalanced upward force of 160 pounds at the end of each stroke. If the centers of the cylinders are 10 inches apart the rocking couple will be 3010 inch-pounds. If the cranks are unbalanced it will be about double this.

As will be seen, by supposing it to be applied at points separated by even half the length of the boat, such a rocking couple as this is quite insufficient to mar the comfort of those on board, and practically it may be neglected altogether. Quite different is it, however, when—as is the practice in some quarters—both pistons are made to go up and down on one crank-pin. Ship and naval designers have recently thrown much light on the subject of hull vibration by showing that the vessel may be regarded as an elastic unit, having "nodes" and "loops" like a stretched string, and a definite time of vibration of its own. The principal loop will have its center just aft of the middle, and the nodes will be from one-fourth to one-third of the boat's length from the ends; and if the engine be placed near the middle of a loop or over a node, and its vibration is of similar character (*i. e.*, up and down if at a loop, or rocking if at a node), unpleasant, or even dangerous, harmonic vibrations will be set up when the engine's revolution-time approaches the natural period of the hull. No one has yet pursued this investigation into the domain of small craft, and he would be a bold syllogist who should argue from the "Lucania" or the "Farragut," with their vibrant steel hulls and flowing lines, to the dumpy models of the typical wooden launch. Nevertheless, the comparison will help us to understand why it is that the single-throw two-cylinder engine, placed near the middle of a boat, shakes it so abominably. It would be hard to find a better example in this sort of what should not be done than is afforded by one of the most popular launch motors at present on the market. This engine, whose success is due to the excellence of its vaporizer, igniter and other special features, not only works both pistons on a common crank-pin, but does not, I believe, even balance the cranks. With these opposite and a little overbalanced, it might easily be run 400 revolutions or over, but instead of this it is slowed down to 340; and the vibration being still excessive the explosion must needs be rendered as "soft" as possible by a compression of less than 35 pounds above atmosphere. As a result, although weighing more than 800 ponds, the motor develops only a little over 6 horse-power, when with 50 pounds or so transferred from the frame to balance weights, and with a few dollars extra expense, it might be put in a larger boat and rated at 8 horse-power. A simple calculation will show that, with the centrifugal force of the crank-pin, etc., added to the pistons, the upward jerk cannot be less than 1,000 pounds—more than the whole weight of the engine.

The usual reason assigned for the single-throw arrangement is that it permits the impulse and idle strokes to alternate regularly, whereas with opposite cranks two impulses are followed by two idle strokes, which is supposed to detract from the smoothness of running and demand a heavier flywheel. For stationary engines this is quite correct—although the difference is less than is sometimes thought—and no smoother running engines could be found than, for example, the Westinghouse, with their alternate impulses and balanced cranks. But the Westinghouse engines are bolted down on heavy masonry foundations, which is an entirely different matter; and with the slow speed at which such engines must necessarily be run in boats the loss of flywheel inertia

more than offsets the slight gain in regularity of impulse.

The cranks, connecting rods and reciprocating parts, which give rise to what may be called the mechanical vibrations, are all that need to be considered in the steam engine. In the gas engine, however, the intermittent character of its impulses constitutes a new source of vibration whose importance may exceed that of all the others together. "Action and reaction are opposite and equal," and each successive explosion, while it tends to rotate the shaft, tends with equal force to rotate engine, boat and all on board in the opposite direction. In the steam craft this torque reaction, as it may be called, produces only an imperceptible heel; but with gasoline, the crank effort rising from nothing to a maximum at each explosion, every impulse is felt as a distinct shock. With 6x7-inch cylinders in a hull of the beam mentioned, the peak of the crank-effort curve represents a force of some 200 pounds applied at one edge of the boat a half-dozen times a second. It is this abruptly varying reaction which is doubtless responsible for the mistaken, but very common, notion, that the "blow" of the explosion tends to lift the engine vertically from its foundation. Of course, nothing of the sort is true, because the vertical component of the connecting-rod thrust is borne by the engine frame, and only the horizontal component is sensible externally; but motors have been designed to overcome this imaginary difficulty, in which the cylinders were oppositely disposed about the crank shaft, in order that the explosions, occurring simultaneously in both, might "balance" each other.

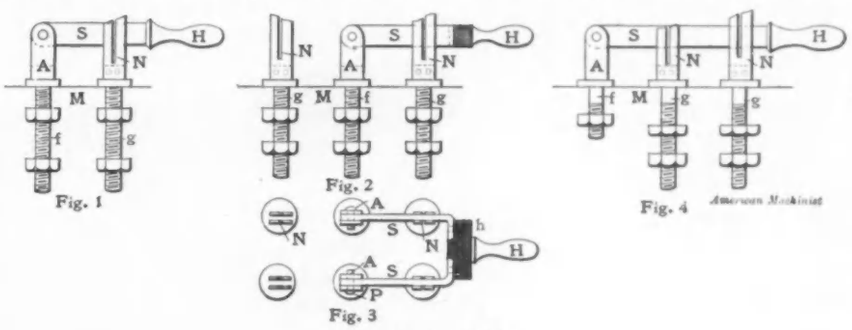
Electrical Switches—I.

BY WM. BAXTER, JR.

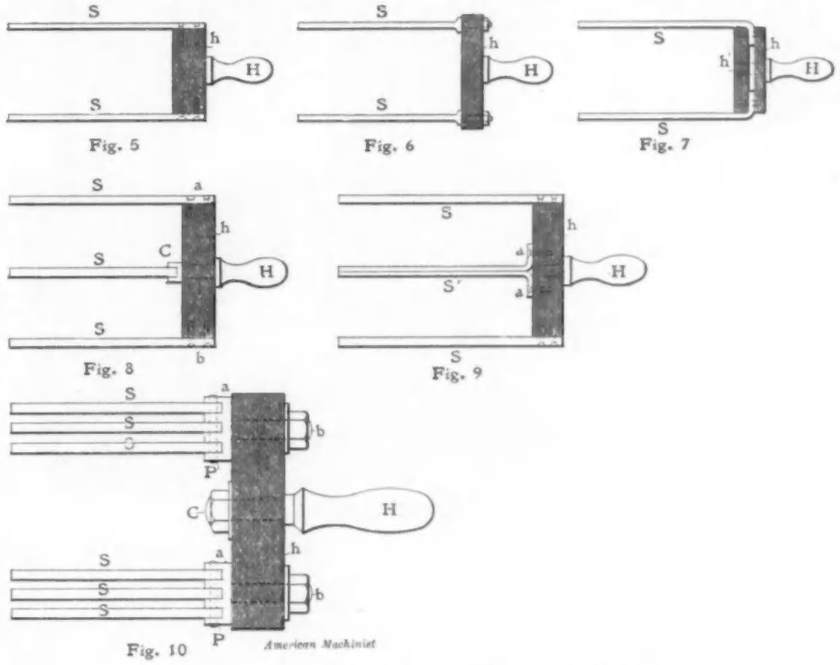
The switches used on switchboards are almost invariably of the type known as knife switches. They are given this name from the fact that the blade moves in a plane perpendicular to the switchboard surface, like a meat shaver. Switches in which the blade moves in a plane parallel with the surface of the board are occasionally employed, when it is desired to connect one terminal with any one of three or more other terminals. Switches of this latter type are designated as side-throw switches. The appearance of a simple knife switch, seen from the side, is shown in Fig. 1, in which S represents the switch blade, A and N the terminals, M the switchboard surface and f g the studs by means of which the terminals are secured in place and are connected with the conductor bars, back of the board. When the switch is in place, if the conductor bars that connect with the studs can be located near the back of the board, they are clamped between the nuts shown, as was described in the articles upon switchboard construction. In that case the nut next to the board is made with a flat face on both sides, so that the conductor bar may be clamped between as large surfaces as possible. If the conductor bar is to be held at some distance from the back of the board, another nut is placed upon the stud. In a switch such as shown in Fig. 1 the current passes from A to N when S is in the horizontal position, as shown, and when S is raised, so as to not be in contact with N, the circuit through the switch is open. As the current passes from A to N, it is necessary that A should fit well against the sides of S, and clamp it with sufficient pressure to insure a good contact. For the same reason, N must be made so as to press against the sides of S and also so as to make as perfect a contact as possible. The dimensions of the several parts of the switch are made such as to be able to carry the current for which the device is designed, without overheating or offering too much resistance to the passage thereof. On this account, as a rule, the parts are very much larger than would be necessary for mechanical strength alone, except in the case of switches intended for very weak currents.

The switch, Fig. 1, is called a single-throw switch, because the blade can only be thrown in one direction to close the circuit. The design shown in Fig. 2 is called a double-throw switch from the fact that the blade will close the circuit if thrown in either direction. If f is connected with one of the conductors coming from a generator and the studs g g are connected with conductors leading to different lighting or motor circuits, then the generator current can be diverted from one circuit to the other by throwing the switch from one side to the other.

If the switch has but one blade it can only open or close the circuit in one wire, and is, therefore, called a single-pole switch; but if S consists of two blades, as shown in Fig. 3 which is a plan of Fig. 2, then if the two blades are insulated from each other, each one can open or close the circuit through one wire. Switches of this latter type are called double-pole, and if S consists of three insulated blades the switch is three-pole. As can be seen, any number of blades can be arranged side by side, thus giving rise to switches of four, five, or any other number of poles; but practically only the



TYPES OF SWITCHES.



VARIOUS METHODS OF INSULATING THE BLADES.

two and three-pole types are used to any extent. In Fig. 2, as well as in Fig. 1, the current passes through *A*, therefore there must be a perfect fit between *A* and *S*. In Fig. 4 the current does not enter through *A*, hence a loose fit will answer as well as a tight one. In this last figure the current passes through the blade *S* from *N* to *N*; therefore at these points a good fit is required, and *N* must exert a considerable pressure against *S*. It can be readily seen that if the blade *S* is raised in Fig. 4 it will produce two breaks in the circuit, for if the circuit comes through the left-hand *N* it will have to jump to *S* after the latter has moved out of the contact, and will then have to jump from *S* to the right-hand *N*, thus being compelled to span two air gaps. On this account switches of this construction are called double-break switches.

From the fact that switches can be made with any number of blades *S*, and that they can be arranged to make a connection in one direction, as in Fig. 1, or in two directions, as in Fig. 2, and from the fact that they can be arranged so as to drop into two or more contacts *N*, it follows that a great variety of combinations can be effected, giving rise to the numerous combination types. Thus, a two-pole, double-throw, double-break switch would be one with two blades *S*, and arranged to close the circuit when moved in either direction, as in Fig. 2, and provided with two contacts *N N* on each side of the center pivot. The switches used on switchboards are of the following types: Single-pole, single-throw; single-pole, double-throw; double-pole, single-throw; double-pole, double-throw; three-pole, single-throw; three-pole, double-throw. All these varieties are also made with double-breaks. In some instances switches are made so that they are not of the same type when thrown in an opposite direction; thus we may have a three-pole switch double-break when the lever is thrown to the right, but when it is thrown to the left it may be only two-pole. Such a modification is obtained by simply leaving out the *N N* contacts that engage with the center blade of *S* on one side.

If the two sides of *S* in Fig. 3 are not insulated from each other, the switch cannot be used as a double-pole. If the voltage of the current that passes through the two sides of a double-pole switch is low, the insulation need not be very formidable, but for any electro-motive force greater than 110 volts the most substantial insulation must be provided. When a two-pole switch is used to connect a generator with the switchboard, the outgoing current passes through one of the blades *S* and the returning current passes through the other, and since it is much easier for the current to jump across from one side of the switch to the other than to make the journey through a long circuit, it will certainly make the jump if there is any weak point in the insulation. To properly insulate the sides of multiple pole switches several styles of construction are resorted to, one of which is shown in Fig. 3. This consists in providing a block *h*, which is made of hard rubber, fiber or hard wood, the former being used for the higher grade of switches and for high voltages. The sides *S S* are bent around at right angles at the ends and are secured to *h* by means of screws.

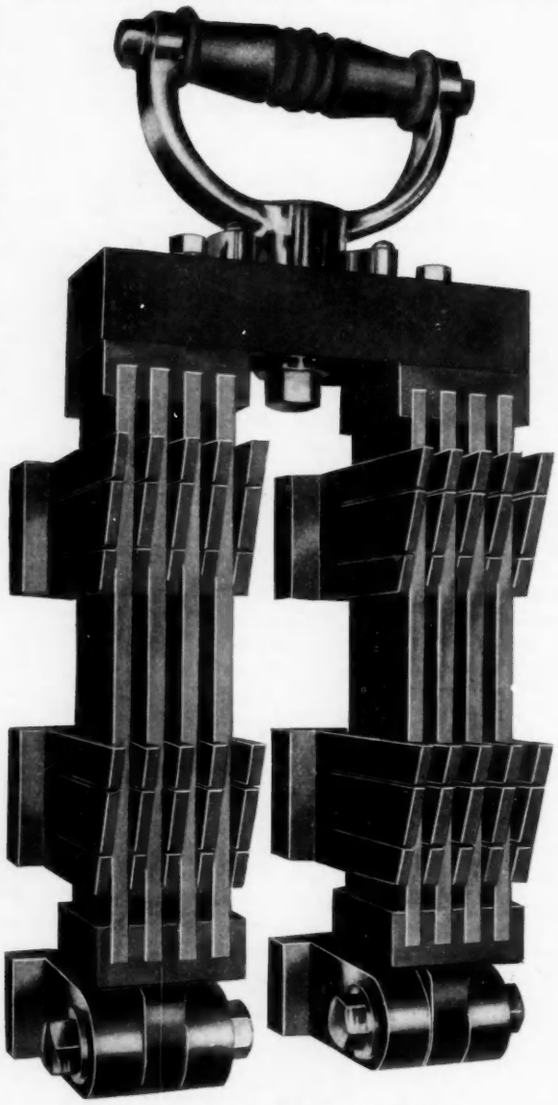


FIG. 11. A SWITCH OF LARGE CAPACITY.

Other constructions are shown in Figs. 5 to 10. The construction Fig. 5 is superior to Fig. 3, electrically considered, because there is a greater distance between the two blades, and therefore less chance for the current to cut across from one to the other; but this construction can be rendered less safe electrically if the screws that hold *S S* are so long as to bring their ends close together. Mechanically considered, Fig. 5 is inferior to Fig. 3, as it is more liable to work loose, although this objection can be reduced by using round head screws that fit well in the holes in the blades. The construction of Fig. 6 is good mechanically, and superior to the two just considered, so far as the insulation goes, but it has the objection that the blades are cast and have a higher resistance than the rolled blades. Fig. 7 is simply a modification of Fig. 3.

Figs. 8 and 9 show constructions for three-pole blades, and Fig. 10 is the type employed for switches of large capacity. When a strong current has to be transmitted through a switch, it is not sufficient to make the several parts of sufficient cross-section to carry the current without becoming overheated, but it is also necessary to provide a sufficient amount of contact surface, for if this is not provided the heat developed at the points of contact may be enough to absorb a considerable amount of energy, and, in extreme cases, may even result in burning out the switch, with more or less serious results. By providing three blades side by side for each pole, as in Fig. 10, the surface of contact is increased three-fold. In this construction the blades *S S S* are secured into the end castings *a* in any suitable manner, a simple construction being to mill grooves in *a* of the proper width for the blades, and hold these in place by pins *p*. A perfect fit at these joints is not required, as the current does not pass through them, therefore all that has to be provided is a substantial mechanical structure. The actual construction of large switches of this kind can be better understood from Fig. 11, which is a switch made by A. La Roach & Co. of 3,000 amperes capacity. As will be noticed, this switch is of the two-pole, double-break type, hence the current passes through a portion of the blade length only, and does not have to cross the joints between the blades and the end castings into which they are secured. On account of the switch being of the double-break type, it is not necessary to provide a large contact surface at the joint upon which the blades swing, but if the switch were of the single-break type the four blades would have to be carried down to the joint and would have to fit accurately at that part.

When a switch is opened through which a strong current is passing, a large spark is formed as the switch blade leaves the contact, and the effect of this spark is to burn away the metal of both parts. This

burning not only results in gradually consuming the working parts of the switch, but by roughening up the surfaces destroys the perfect contact. The trouble can be remedied by smoothing off the burned portions with a file, but this procedure, in the hands of a man who is not a good mechanic, soon spoils the switch by destroying the fit between the contact surfaces. The extent to which the parts are burned by the spark is dependent not only upon the strength of the current, but also upon the duration of the spark; therefore, if the time during which the spark holds out

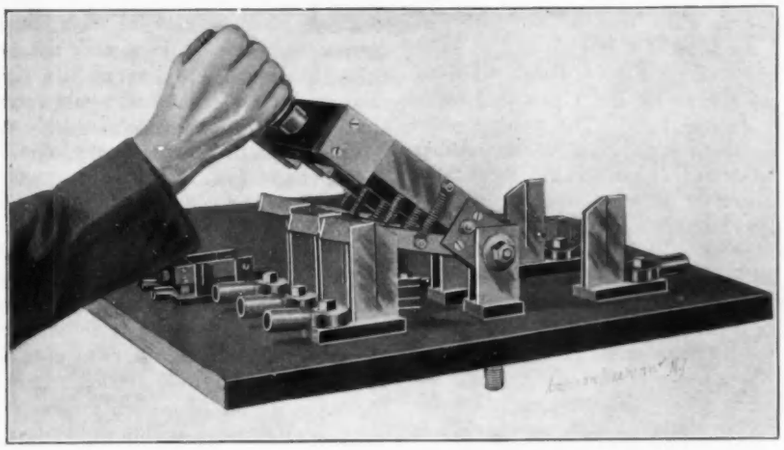


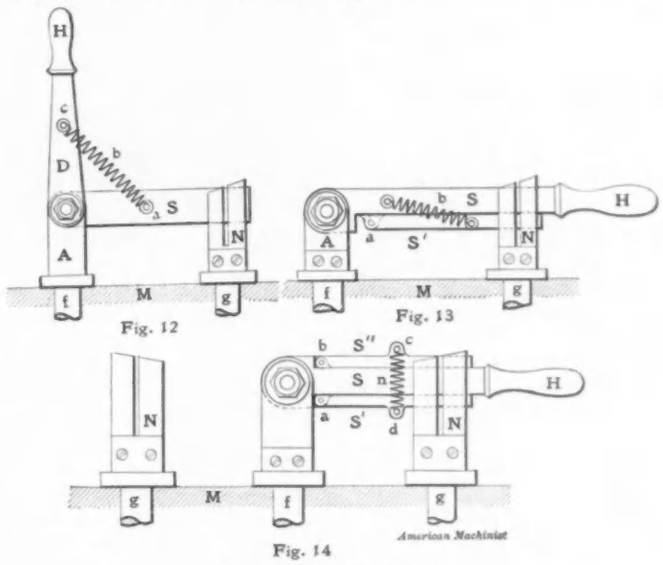
FIG. 15. THREE-POLE, QUICK-BREAK SWITCH.

can be reduced, its destructive effects can be reduced. To reduce the duration of the spark switches are made so as to move quickly after they break contact, and the way in which the result is accomplished can be understood from Figs. 12 13 and 14. Switches of this kind are called quick-break or snap switches. In Fig. 12 the lever *D* is not a part of *S*, but is connected therewith by means of the spring *b*. When the handle *H* is moved to the left *S* will remain in contact with *N* until the spring *b* is stretched to such an extent that its force can overcome the frictional resistance, then *S* will be released and fly up very rapidly. The spark between *S* and *N* will break when the separation between them reaches a certain amount, and the quicker the movement the sooner this distance will be reached, hence, the shorter the duration of the spark. In Fig. 13 the part *S'* is hinged upon *S* at *a*, and is drawn into the position shown by the spring *b*. When the handle *H* is raised, *S'* remains behind until the force of the elongated spring pulls it away from *N*. In Fig. 14 the parts *S'* and *S''* are hinged to *S* at *a* and *b*. They are held against *S* by the spring *n*, which is attached to *c* and *d*. The action of this switch is the same as that of Fig. 13, the only difference being that it is of the double-throw type. Fig. 15 shows a three-pole switch of the type shown in Fig. 14, the handle being raised to the point where the side bars are about to leave the contacts *N*. This switch, as will be noticed, is three-pole on the front side, but only two-pole on the back.

The Deceptive Fracture of Pig Iron —The Segregation of Iron in Casting.

At the Pittsburgh meeting of the American Foundrymen's Association a paper was read by Mr. Thomas D. West on "The Deceptive Fracture of Cast Iron." The aim of the paper was to call attention to the reliability of chemical analysis for the selection of pig iron, and to contrast it with the deceptive and misleading evidence of fracture alone. The gist of the paper may be found in the following extract:

"The foundation of the old-school method in regulating mixtures is based on the belief that the appearance of pig fractures truly defines the character of iron as to the degree of hardness. The founder's own experience in knowing that he can make soft and hard castings from the same ladle and at one pouring, if he choose to so construct his molds, should be sufficient to prove to him why it is possible for two furnace casts of pig metal that are alike in chemical analysis, or which will give the same results when melted, to differ so widely in appearance that the fracture from the one cast will seem close-grained or hard in the pig, while the other will be the reverse. A founder can take the same ladle of iron, and by pouring part of the metal into a mold that will chill or solidify quickly, produce a fracture that will be close-grained in the one case and open in the other. This is just what the furnaceman does in making pig iron. One part of his tap, or cast of iron, may run so slowly from his furnace as to chill the metal before it reaches the pig beds, while another tap or cast may come so fast as to fill the pig beds so rapidly that it will take quite a while for the metal to solidify. Again, one tap or cast at a furnace may give much hotter iron than another, and it is natural that the dull iron should cool faster than the hot, and, if both run at the same speed from the furnace down the long runners to the pig beds, will give the closer grained iron in the case of the duller metal. Surely the founder should perceive from this why the same kind of iron may have in one cast a close grain, and in another an open grain. As there are but few molders or founders who have ever had the opportunity of witnessing a furnace cast, this explanation of its workings, combined with their own foundry experience, should assist many to realize why the fracture of pig metal is an unreliable guide to the iron's true grade."



QUICK-BREAK SWITCHES.

In the discussion which followed the reading of the paper, Mr. Kreuzpointer said, in part, as follows:

"The selection of the proper grade of pig iron is the foundryman's great concern, and Mr. West has pointed out very clearly in his paper that one of the prin-

cipal weapons with which the foundryman fights the industrial battle of to-day, is antiquated and defective, inasmuch as the present method of selecting pig iron by fracture is defective and misleading.

"How is the structure formed which we see on breaking a pig? A molten mass of iron in the blast furnace, cupola or ladle, is a combination of chemical elements, held in solution by the fluid mass of iron, as salt or sugar is held in solution by water. Each of these elements, when by itself, has a different melting point and point of solidifying when cooling. Now it is a peculiarity of chemical elements that some of them are attracted to each other, thus forming a combination more readily than other elements. This tendency to mutual attraction we call affinity. As soon as the iron gets cold enough, crystals are forming, and these crystals try to extract out of the surrounding fluid metal all the elements necessary to their growth. Thus the crystals grow as long as they have an opportunity to extract some of the substances surrounding them. Hence, if we cool iron quickly we prevent the crystals from growing any further, and they will have the size, therefore, the crystals had when stopped from growing further, and not the size representative of any particular chemical compound, generally speaking. This is clearly shown by the samples exhibited here by Mr. West, the pieces of small cross-section having a fine structure, because they cooled quickly and the crystals had no time to grow larger, while the larger sized sections have a coarse grain, because they had more time to grow, due to slow cooling. The fractures of the test bars exhibited by your Committee on Standard Tests show the same phenomenon. A couple of years ago I came across a very striking instance of the effect of time in cooling, on the size of the crystal structure of iron and steel. A large amount of the contents of an open hearth furnace escaped through the bottom of the furnace. The bottom was repaired and the metal left where it was until the furnace had to be torn down. Here had been an opportunity for the escaped metal to cool very slowly. As a consequence the crystals in that mass of soft steel were of extraordinary size. I obtained a well-formed crystal, which measured 1⅜ inches in length and ⅝ inch in width. I have still a piece of that metal with a crystal imbedded, measuring ⅝ inch. Ordinarily the crystals of such steel in the ingot measure a few hundredths of an inch.

"Now, while such an instance as just mentioned is very rare, yet it furnishes proof of the importance and influence of time in cooling a molten mass of iron on the size of structure, irrespective of chemical composition. You can readily imagine the gradations in size of structure, due to time of cooling, between the crystal 1⅜ inches long, and the fine structure we might be able to obtain in the same metal by instantaneous cooling of the mass. For the same reason, an iron low in silicon may have as coarse, if not a coarser fracture, than an iron high in silicon and graphitic carbon.

"There is another property of cast iron, with which the foundrymen are much concerned, but which thus far has not received the attention it deserves. Cast iron is an alloy composed of iron and other substances. Now the melting point of alloys varies with the variation of the percentage of constituents forming the alloy. Thus, for instance, wrought iron melts at 2,912 degrees Fahr., gray iron at 2,280 degrees Fahr., and white iron at 2,075 degrees Fahr. An alloy of 1 part tin and 25 parts lead melts at 558 degrees Fahr., while an alloy of 6 parts tin and 1 part lead melts at 381 degrees Fahr. The melting point of tin alone is 451 degrees Fahr., and that of lead is 618 degrees Fahr. Naturally, an increase in the number of elements in an alloy and variations in the percentages of elements, will produce complications in the melting points of alloys. These complications are increased by the law of affinity, according to which certain elements will attract each other and combine with one another more readily than other elements. They will flock together like birds of a feather, as the saying is. It must be obvious that, during the formation of such complications, the rate of cooling again plays an important part.

"But to fill the foundryman's cup of bitterness and perplexities to overflowing sometimes, and to make him scratch his head in wonderment as to what will come next, there is the phenomenon of segregation in alloys, and cast iron is very much affected by this phenomenon. Iron, like water, has the ability, when in a fluid state, to dissolve and hold in solution foreign substances. But when a fluid mass of iron cools down to the point of solidification the foreign substances, held in solution while the iron was fluid, segregate out of the iron, one after another, the same as salt segregates out of the water whenever there is more salt dissolved in a hot brine than the water can hold when cold. Now the iron can hold more carbon, silicon, etc., chemically combined, when in a fluid state than it can hold in a solid state. Consequently, when a molten mass of cast iron freezes, so much of the foreign substances held in solution by the molten iron as cannot be held by the solidified iron will be pushed out, or segregate out, until the mixture reaches certain proportions. This mixture having reached such proportions of elements as is peculiar to cast iron, will be the last portion in a casting to freeze, or solidify. This mixture in alloys freezing last is called the mother metal in alloys of metals, and mother liquor in other mineral solutions, for cast and pig iron are nothing but mineral solutions after all.

"According to Roberts-Austin and Juptner von Johnstorff, the mother metal of cast iron is composed of 95.7 per cent. of iron and 4.3 per cent. of carbon. The mother metal of an alloy of copper and silver contains 28 per cent. of copper and 72 per cent. of silver. Whenever, therefore, in an alloy an excess of elements is present, over and above the proportions necessary to form the mother metal, then this excess will separate, or freeze out, or segregate out of the molten mass and solidify before the mother metal freezes or solidifies. This is the reason why a plumber can make a wiped joint. If he would take a mixture of lead and tin, or whatever metal he uses, of such proportions as to just form the mother metal of a tin-lead alloy, he could not make a wiped joint, because his mixture would freeze, or solidify, under his hands so quickly that no time would be left to wipe the joint, but having an excess of lead, this excess freezes first, and continues freezing while the plumber is wiping his joint, until so much of the lead has frozen, or segregated out of the mixture, as to leave a proper proportion of metals to form the mother metal. When that point is reached, the whole of the mixture freezes at once and altogether, without any further segregating out of the one or the other metal.

"Now, this same action takes place in cast iron, or other alloys, and this segregating out for the excess of elements in alloys, over and above those proportions necessary to form the mother metal, or eutectic alloy, as scientists call it, is a disturbing factor of unknown influence in the brass and iron foundry. On account of this, cast iron has two cooling points instead of one. In other words, the excess of elements present, over and above the mother metal, solidify or freeze first, and at a higher temperature than the mother metal. For instance, a mixture of cast iron with 98 per cent. of iron and 2 per cent. of carbon will solidify at 2408 degrees Fahr., but if the iron is given time enough to cool slowly for the segregating out of the excess of iron over and above 95.7 per cent. of iron and 4.3 per cent. of carbon, which is the mother metal of cast iron, then that iron will solidify at two different temperatures, viz., the excess at about 2408 degrees Fahr. and at 2066 degrees Fahr., which is the freezing point of the mother metal, or eutectic alloy, of cast iron.

"The practical lesson for the foundryman from all this is, that if he knows he has the right mixture for a given purpose, to try and pour his iron at a sufficiently low temperature, so as to prevent segregation as much as possible in large castings. Under unfavorable conditions such segregated castings, notwithstanding the chemical composition is all right, may be weak, because of the want of homogeniety of the structure. The casting may appear solid enough, but when a casting has happened to solidify at two different temperatures,

the structure, or grain, cannot be uniform throughout the mass, and there is liability of lines of weakness running through the casting between the juncture of patches of coarser grain and finer grain.

"The largest of the sections of the test pieces exhibited by your test committee are good object lessons of the influence of time of cooling on the size of the grain and the formation of segregations in their worst form. We can also readily see that it is not always the chemical composition alone that secures a good, strong and sound casting. We can also imagine what possibilities there are in alloys in general, and cast iron in particular, for the formation of an endless variety of combinations and complications, due to this peculiarity of segregation in alloys of metals, and the greater the number of elements present the greater the liability for complexities."

Some Facts About Steamships.

The president of the Mechanical Science section of the British Association, Sir William White, in his presidential address paid attention chiefly to developments in steam navigation, and, speaking of the transatlantic service, said:

"Sixty years of continuous effort and strenuous competition on this great 'ocean ferry' may be summarized in the following statement: Speed has been increased from 8½ to 22½ knots; the time on the voyage has been reduced to about 38 per cent. of what it was in 1840. Ships have been more than trebled in length, about doubled in breadth, and increased tenfold in displacement. The engine power has been made forty times as great. The ratio of horse-power to the weight driven has been increased fourfold. The rate of coal consumption (measured per horse-power per hour) is now only about one-third what it was in 1840. To drive 2,000 tons weight across the Atlantic at a speed of 8½ knots about 550 tons of coal were then burned; now to drive 20,000 tons across at 22 knots about 3,000 tons of coal are burned. With the low pressure of steam and heavy, slow-moving paddle engines of 1840, each ton weight of machinery, boilers, etc., produced only about 2 horse-power. With modern twin-screw engines and high steam pressure each ton weight of propelling apparatus produced from 6 to 7 horse-power. Had the old rate of coal consumption continued, instead of 3,000 tons of coal, 9,000 tons would have been required for a voyage of 22 knots. Had the engines been proportionately as heavy as those in use sixty years ago, they would have weighed about 14,000 tons. In other words, machinery, boilers and coals alone would have exceeded in weight the total displacement of the 'Campania' as she floats to-day. There could not be a more striking illustration than this of the close relation between improvements in marine engineering and the development of steam navigation at high speeds."

A New Light Driller.

A good many forms of light sensitive drills have been brought out from time to time, but we illustrate herewith one which seems somewhat remarkable in point of simplicity, and it has a new feature by which the spindle is automatically put in motion when the drill is brought down to the work, and automatically comes to rest when raised. This is done by the very simple expedient of placing a narrow, loose pulley on the spindle in such a position that when the spindle is in its uppermost position the belt runs upon this loose pulley, and when the spindle is brought down the belt runs upon the broad face of the tight pulley above the loose pulley, and is thus set in motion. The other features of the machine are, as will be seen, similar to other machines of its class, and it is made by the Union Tire Company, Plainfield, N. J.

A NEW LIGHT DRILLER.

Massachusetts Institute of Technology.

On Wednesday, September 27, the exercises of the Massachusetts Institute of Technology will begin. Since the end of the last term some changes have been made in the faculty. Adolph Rambeau, Ph.D., has been made Professor of Modern Languages, and has charge of that department. Arthur A. Noyes, Ph.D., formerly Associate Professor of Organic Chemistry, has been made Professor of Theoretical and Organic Chemistry. Jerome Sondericker, C. E., formerly Assistant Professor of Applied Mechanics, has been made Associate Professor of Applied Mechanics. Allyne L. Merrill, S. B., formerly Assistant Professor of Mechanism, has been made Associate Professor of Mechanism. Edward F. Miller, S. B., who was Assistant Professor of Steam Engineering, has been made Associate Professor of Steam Engineering. Carleton A. Read, S. B., who was an instructor in Mechanical Engineering, has left to take charge of the Mechanical Engineering Department in New Hampshire College at Durham. George V. Wendell, Ph.D., has has returned from three years' study in Germany and resumes his duties as Instructor in Physics. Frederick H. Keyes, S. B., and Alexander W. Moseley, S. B., have left to take up professional work. Frederick A. Hannah, S. B., has accepted a position in the Mechanical Department of the Brooklyn Polytechnic Institute. Captain John Bordman, Jr., who was Instructor in Military Science, is on his way to the Philippines with the Twenty-sixth United States Infantry, of which he is the regimental Adjutant. Myron L. Fuller, who was an Assistant in Geology, has been made an Instructor in Geology. The following men have been made Assistants: Henry E. Andrews, A. B., in English; Alvan L. Davis, S. B., in Mining Engineering; F. L. H. Kimball, S. B., in Mining Engineering; Miles S. Sherrill, S. B., in Analytical Chemistry; Etheredge Walker, S. B., in Mining Engineering; William S. Newell, S. B., in Mechanical Engineering; George H. Riker, S. B., in Mechanical Drawing, and Frank R. Swift, in Mechanical Engineering.

The Franco-American Reciprocity Treaty—The Paris Exhibition.

I dare say your readers will have heard a great deal about British firms having withdrawn from their undertaking to exhibit at the forthcoming Paris Exhibition in consequence of the Dreyfus verdict. I don't think your manufacturers ought to be under any delusion on this head, as I am informed by the managing director of the Paris Exhibition Agency that only three of the 640 British exhibitors have withdrawn from this cause. Our British manufacturers are not so enthusiastic Dreyfusards that they are willing to give their rivals a chance against them. For any firm willing to retire there are quite a hundred willing to take their place. In these circumstances I need hardly state that purely humanitarian motives do not count for everything. What has been damaging the chances of the exhibition in the eyes of foreigners is the unsettled state of the political situation in France and the antipathy felt by the French towards aliens.

You are, of course, aware of the main facts about the Franco-American treaty

of reciprocity, but some of the more important details have probably not come to your knowledge. The treaty, which was signed at Washington on the 24th of July, has to be ratified by the Senate within eight months of that date, but has also to be ratified by the French Parliament. It does not seem by any means certain that it will be so ratified, especially in the case of France, as governments there change so often and so unexpectedly. The treaty has aroused a great deal of bitter feeling among the French industrial classes, and if a more protectionist government gets returned to power in France over will go the treaty.

The United States have granted France reductions on several of your manufactures, among them being cutlery, 10 per cent. off the general tariff; nails, spikes, points and needles, 15 per cent.; other goods, composed wholly or in part of manufactured metal, not specially provided for, 10 per cent. In addition to the reductions named above, the United States accords France the treatment of the most favored nation, while France pledges herself to grant United States the benefit of her minimum tariff with the following exceptions: Electric dynamo machines, machine tools, parts of electrical machinery and regulator arc lamps, also cast iron. There are also various other lines which are excluded from the minimum tariff, but they do not interest your readers. As I explained some months ago when writing on this subject, the benefit which the minimum tariff gives is about 20 to 30 per cent.

The lines in which the greatest expansion may be looked for are, primarily, agricultural implements. There is a great demand in France for your farm machinery and tools, and the trade has hitherto been handicapped by the extra tariff which importers have hitherto had to pay under the maximum tariff. During the three years ended December, 1898, the shipments in this direction have risen from $453,000 to $1,296,000—more than the English trade by a few thousand dollars. Cycles, too, are another line which should be shipped in greater quantities, as the trade has been steadily growing of late years.

The trade in electric light machinery, which is barred from the minimum tariff, only amounts to $247,872 a year, including general apparatus for scientific purposes, so the trade does not amount to anything very serious. It is a great pity that machine tools do not benefit under the new treaty, because the trade is an expanding one; but in any event French engineers must go to the United States for certain tools, as they cannot get them elsewhere. It is, no doubt, felt in France that to give American makers the benefit of a lower tariff would be to severely handicap French machine tool manufacturers. The present treaty is undoubtedly a move in the right direction, as it tends to expand the foreign trade of the United States. It will also be remembered that the "American Machinist" was the first technical journal to urge the necessity of obtaining the benefit of the French minimum tariff.

F. C. CHAPPELL.

Paris, September 20.

Letters from Practical Men

The Tail-Rope System of Balancing Hoisting Engines.

Editor American Machinist:

I have been very greatly interested in your articles describing the hoisting engine of the Tamarack Mining Company in the issues of September 7 and 21, and in the editorial on the subject in the former number, in which you have so clearly set forth the difficulties in the way of successfully designing this class of engine, and some of the very ingenious expedients which have been used to overcome them, especially those relating to the varying load on the engine, due to the changing length of the suspended portion of the rope.

The figures you give of the conditions of the Tamarack Company's mine are an admirable illustration of the matter and need no further comment. I should, however, like to call your attention to a method of compensating for the varying weight of the hoisting rope, which I believe is still quite new, relatively speaking, but whose simplicity and effectiveness should ultimately cause it to be better known. Before proceeding to this, however, it may be well to point out two of the serious defects of the conical drum. In the present case the diameter of the larger part seems to be slightly more than twice that of the smaller. With total weights acting on the two drums of 42,000 and 8,000 pounds when the loaded cage is at the bottom of the shaft, and of 20,000 and 30 000 when the loaded cage is at the surface, as given by your figures, and assuming for convenience a ratio of largest and smallest drum diameters of two to one, the moments on the up and down sides become, with the load at the bottom, as 21,000 to 8,000, and with the load at the top as 20,000 to 15,000, or a net moment of 13,000 in one case and 5,000 in the other.

This is a tremendous variation of load, and means that the engine is not only greatly underloaded in the upper part of the cage-travel, and consequently uneconomical, but that the engine required to be built large enough for a maximum torque of 13,000 instead of an average torque of 9,000.

Consider, also, that there is in practice a limit to the speed of cage-travel and to the speed of rotation of the engine; then it follows that either the cage-travel at the bottom is only one-half of its permissible maximum, while the engine runs throughout at its proper speed, with a loss of one-quarter of the total time of hoisting, the average speed of the cage being only three-fourths of what it might be, or the cage runs at its maximum permissible velocity throughout its travel, while the engine speed is reduced one-half during a large part of the time, which means that the engine has to be larger than it would otherwise require to be to do the work, to say nothing of the difficulty of having the engine run at a gradually decreased rate of speed.

These two points have proven the "fly in the ointment" of the designers of the conical drum hoists.

In order to avoid these difficulties it occurred to someone to do one of those brilliantly simple things whose very virtue is their inventor's or originator's undoing, their simplicity making them equally useful and unpatentable. I am sorry that I cannot give the name of this particular genius, but I cannot, for I do not know who he was, nor when or where he flourished, but what he did was to tie one end of a rope of the same weight per foot as the hoisting rope to the bottom of each of the cages and let the bight of it pass around an idle "bull wheel" at the bottom of the shaft.

It doesn't require any fine figuring or careful designing, and it doesn't look like much of a thing to do at all; but it simply does the whole thing so completely that there is nothing more to be said or done. There is always a full length of rope hanging on each side of the drum, and, of course, the two balance each other at all times and in all positions; the cages and cars, of course, balance each other, just as in any two-cage shaft, and the only load the engine has to consider from top to bottom is the live or paying load, in this case a maximum and constant load of 12,000 pounds, against the widely varying load of the system illustrated.

The total strain on the hoisting rope is no greater than its maximum with the conical drum, but is constant at that, while the balancing rope, having only its own weight to sustain and being free of the cage, etc., does not need to be as strong as the hoisting rope by a very considerable amount, in the present case, with a very unusually deep shaft, just about one-half, so that a rope condemned for hoisting service is perfectly good for this, and consequently, once the system is started, the cost of balancing rope is negligible, to say nothing of its probable long endurance under the light strain and small amount of bending it would have to undergo.

With this arrangement, of course, the drum is cylindrical, the speed of hoisting and of engine are both constant, and the engine need only be large enough to hoist the paying load at its most economical point of cut-off, which is constantly maintained.

It will be seen that with this system both

the first cost and the cost of operation are greatly reduced.

While on the subject of hoisting engines I should like to ask a question which has agitated my mind for a long time; and that is whether there is any valid reason why a hoisting engine of the size and importance of this one should not be compounded?

The orthodox answer, of course, will be that the steam in the receiver when the throttle is shut still acts, and would reduce the power of instantaneous control of the engine, and therefore is inadmissible. But in the present case Mr. Nordberg has put the throttle for each of the four simple cylinders right at the cylinders, so that the steam between throttle and cylinder should be a minimum. Does anyone see any reason why the same could not be done with the compound by putting a throttle between the receiver and the low-pressure cylinder, and, if done, why it would not be of equal effect? Similarly in the matter of starting, if the receivers were heated with live steam as the cylinder jackets are, so that they would always be hot and ready for business, would there be any more difficulty than there is with the present simple engine; and, if so, will someone please tell me what it is? I should particularly like to know.

J. E. JOHNSON, JR.

Gadsden, Ala.

[The tail-rope system of balancing is, we believe, of English invention, and is used to a considerable extent in England and on the Continent of Europe. It will be remembered that with the Tamarack hoist the peculiar combination of straight and conical drums, with its consequent sacrifice of uniform torque, was due to local conditions. Conical drums are, we believe, usually laid out to give substantially uniform torque and effort throughout the hoist, and where this is done the argument based on irregular effort and increased size of engine to meet the maximum torque would not hold. The argument based on the mean speed being below the maximum applies, however, to all conical drum hoists.—Ed.]

Compass for Drawing Arcs of Large Radius.

Editor American Machinist:

In reference to the recent articles about the use of draftsmen's curves, in the "American Machinist," I take pleasure in contributing a description of a simple compass for drawing arcs and circles from 0 to ∞ radius. This instrument is especially adapted to use in the drawing office or pattern shop for drawing arcs of large radius, and it makes any temporary cob-house structure unnecessary, as the whole compass is only 25 inches in length. It is much used in Germany for laying out wheel segments and other work, and consists, as shown in Fig. 1, of the rod A, the brass or iron disks D and D_1, the drawing pen holder P with weight G and an assortment of change disks.

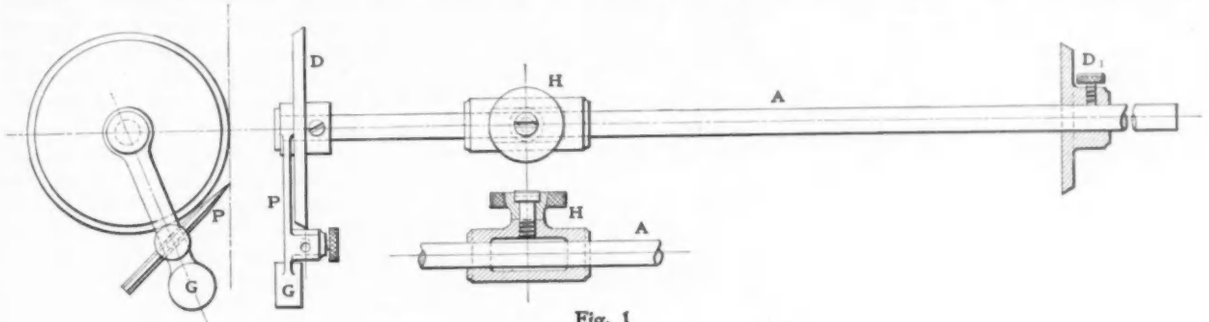


Fig. 1

By placing on the rod A one disk D_1 of somewhat smaller diameter at a certain distance from the other D, it is clear that by rolling the instrument over a plane (by means of handle H), on the principle of rolling cones, every point of the rod will describe an arc of a certain radius.

To find the relations between the to be described radius R, Fig. 2, the distance a between the disk edges and the diameter of the disks d and d_1, we have the following proportions from the similarity of triangles $A\,O\,B$ and $D\,C\,B$:

$$R : \frac{d}{2} = a : \tfrac{1}{2}\,(d - d_1),$$

or

$$R = \frac{d\,a}{d - d_1}.$$

Suppose the disk D on the end of the rod A to remain unchanged, and to equal 4 inches; then we have:

$$R = \frac{4\,a}{4 - d_m},$$

otherwise:

$$a = \frac{(4 - d_m)\,R}{4}.$$

From the last formula we can obtain the following table:

Radius.		Diameter of change disk.	Distance a between steady and change disk edges.
R in inches.	R in feet.	d in inches.	
24 to 96	2 to 8	$d_1 = 3$	$a = \frac{1}{4}\,R$
96 to 384	8 to 32	$d_2 = 3\frac{3}{4}$	$a = \frac{1}{16}\,R$
384 to 1536	32 to 128	$d_3 = 3\frac{15}{16}$	$a = \frac{1}{64}\,R$
1536 to 6144	128 to 512	$d_4 = 3\frac{63}{64}$	$a = \frac{1}{256}\,R$

For example, an arc of 52 feet radius is to be drawn. By above table change disk D_3 with the diameter $d_3 = 3\frac{15}{16}$ is placed on the rod at a distance

$$a = \tfrac{1}{64}\,R = \tfrac{13}{16} \text{ feet},$$

or

$$a = \frac{13 \times 12}{16} = 9\tfrac{3}{4} \text{ inches}.$$

With some little preliminary practice this compass can be used with ease for drawing arcs between two points with a certain radius, or for finding the radius when three points of a circle are given.

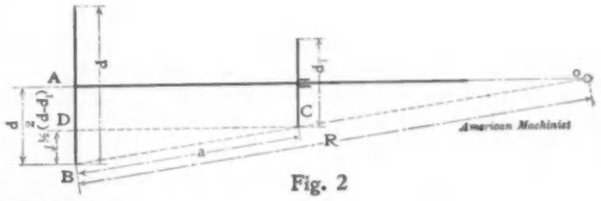


Fig. 2

A COMPASS FOR LARGE CIRCLES.

U. PETERS.

Dundas, Ont.

Computing Compound Gears.

Editor American Machinist:

I suppose there is nothing related to the trade that the young lathe hands, and some of the other fellows in the shop, are more interested in than the figuring out of the gears for cutting threads. It is quite a while since the "American Machinist" has given us any formal articles on this subject, although I remember those of years ago, and I venture to offer here a little about my way of doing things. It may be a little different way, or I may put it in a little different light, and some obscure spots may get more satisfactory illumination.

Say that we have a screw-cutting engine lathe arranged for using the gears either

simple or compound, with a lead screw having a pitch of 4 to the inch, and the following list of gears: 24, 32, 36, 40, 48, 56, 60, 60, 64, 66, 69, 72, 78, 80, 84, 96, 120. This may not be the best possible selection of gear numbers, but they will answer our purpose. There are, of course, two gears alike for cutting the same pitch as the lead screw, and there is also a gear for cutting 11½ threads to the inch for wrought-iron pipe and fittings.

Fig. 1 shows one of the simplest cases of single or direct gearing. Assuming here that the stud turns at the same speed as the lathe spindle, then if the gears on the stud and on the screw were of the same size, or had the same number of teeth they would both turn at the same speed, and the thread cut by the tool would have the same pitch as the lead screw. In this case, however, the driving gear on the stud and the driven gear on the screw have not the same number of teeth. The number of teeth on the screw being the greater, the screw will of course turn slower than the stud or spindle, and the tool will cut a thread finer than the lead screw, or will cut a greater number of threads to the inch. The ratio of the lead-screw pitch to the pitch of the screw that is cut will be the same as the ratio of the gear on the stud to that on the screw. To find, then, the number of threads to the inch that these gears will cut, we have the simple proportion:

$$32 : 72 :: 4 : 9.$$

Here, of course, the operation is $72 \times 4 \div 32 = 9$, or the number of teeth in the gear on the screw multiplied by the pitch of the screw and the product divided by the number of teeth in the gear on the stud gives the number of threads to the inch that the gears will cut.

If, instead of this, we wished to cut a certain number of threads to the inch, we would first select some gear for the stud, remembering generally that if a fine thread is to be cut, a small gear will be required, while if a coarse thread is to be cut, a larger gear must be used. Say that we want to find the gears for cutting 9 to the inch. We select 32 for the stud, and we have this simple proportion:

$$4 : 9 :: 32 : 72.$$

That is, after selecting the stud gear we multiply it by the pitch that we want to cut, and divide the product by the pitch of the lead screw. If we had taken 40 for the stud, then the operation would have been:

$$4 : 9 :: 40 : 90,$$

but as we have not a 90-tooth gear in our list, that would not do.

In simple or direct-connected gearing like this the diameter or the number of teeth in the intermediate gear need not be considered, as the intermediate gear merely transmits the motion, tooth for tooth, from one gear to the other. In the compound gearing on the engine lathe there are two gears on the intermediate stud which revolve together, instead of the single gear. In the compound train shown in Fig. 2 these gears both have the same number of teeth, and it is evident without computation that the result is precisely the same as in Fig. 1. Compound gears are, however, frequently necessary to enable us to cut either finer or coarser threads than would be possible with the simple gearing, and in some cases they enable us also to cut fractional threads that

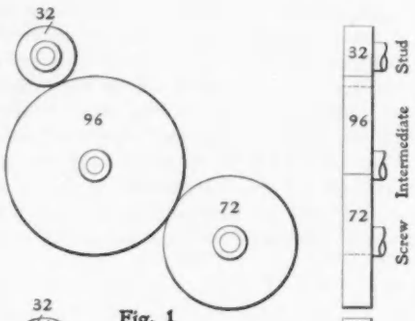


Fig. 1

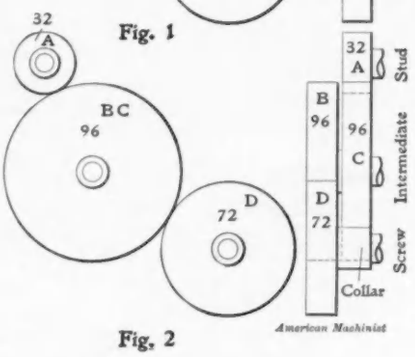


Fig. 2

are not at either extreme as to pitch. In Fig. 3 the train shown is for cutting fine threads, and the train in Fig. 4 is for a coarser thread than the lead screw.

In these trains the gears A and B are designated as drivers and C and D as driven gears. The ratio of the pitch of the lead screw to the pitch of the screw that is cut will be the same as that of the product of the drivers to the product of the driven gears. To ascertain the number of threads to the inch that will be cut by the gears in Fig. 3, we have the proportion:

$$32 \times 48 : 120 \times 96 :: 4 : 30$$

That is, we multiply the driven gears together and this product by the pitch of the lead screw. We also multiply together the two drivers and use this product as a divisor of the previous product, the quotient being the pitch required.

The pitch resulting from the combination shown in Fig. 4 is obtained by the following compound proportion:

$$20 \times 120 : 64 \times 36 :: 4 : \frac{96}{100}, \text{ or } .96$$

This last result must not be misunderstood. The pitch of the thread is not 96 one-hundredths of an inch, but it means that 96 one-hundredths of one thread will be contained in one inch measured on a line parallel with the axis of the screw. The total measure of one thread along this line would be 1 4-96 inch or 1 1-24 inch.

Returning to Fig. 3, say that we have to find the gears to cut 30 threads to the inch. The difficulty in the matter is that we here have to assume, or to "select at random," three of the four gears, when we may easily compute the fourth. It will generally happen that the gears first picked out will not do, and others must be selected and another computation made. In this case we know that, as the thread to be cut is a fine one, the drivers must be comparatively small and the driven gears large. We first take, then, say, the two smallest gears on the list for the drivers, and the largest gear on the list for one of the driven. Then to find the other we have this proportion:

$$4 : 30 :: 24 \times 32 : 120 \times x$$

Then $(24 \times 32 \times 30) \div (120 \times 4) = 48$, the other gear. That is, we multiply together the two drivers and the pitch of the thread to be cut, and divide this product by the selected driven gear multiplied by the pitch of the lead screw, the quotient being the number of teeth for the other driven gear. We now have the full set of gears for cutting the required thread; but when we try to connect them on the lathe, we find that they will not reach. It is evidently necessary to use some larger gears, so we start again with 32 and 48 for drivers, as in Fig. 3, and 120 for one of the driven as before, when the other driven gear is found to be 96, and

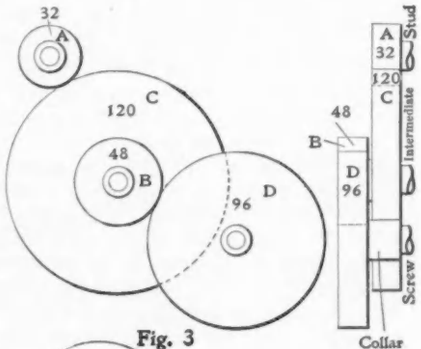


Fig. 3

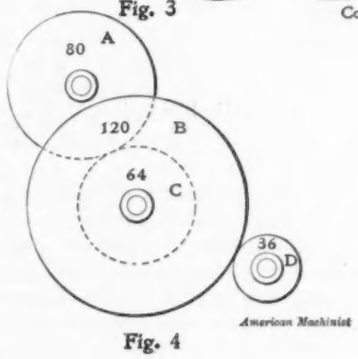


Fig. 4

these connect all right. In this case it was not necessary to restate the proportion and to go through the entire computation again. We have simply taken one driver 24 and one driven gear 48 and multiplied each by 2, giving us 48 for a driver and 96

for the driven gear. A simple case that might be quite likely to come to us would be to cut a screw of 1 thread to the inch. In this case we know that we have to speed up the screw, so we take big gears for the drivers, and we have the proportion:

$$4 : 1 :: 120 \times 96 : 32 \times x$$

and we find that the other driven gear will be 90, making the complete series—drivers, 120 and 96; and driven gears, 32 and 90. When we come to connect these we find that they are too large, so we take the 120 driver and the 90 driven and subtracting a third from each we get, instead, 80 and 60, which have the same ratio as 120 and 90, and our set of gears is then—drivers, 80 and 96; and driven gears, 32 and 60. There is still an objectionable feature about these. The driven gear 32 is too small and will not drive as well as a larger one. We take 40 instead, and in making this larger we have to make the other driven gear smaller to keep the product of the two the same, so we multiply together the driven gears 32 and 60 and divide this by 40, and the quotient will be 48 for the other driven gear, and our set then becomes—drivers, 80 and 96; and driven gears, 40 and 48, which should be a satisfactory train for cutting 1 thread to the inch. There are many other things connected with the manipulation and computation of compound gears and gears for special threads which I may be able to get into another letter.

MORRIS FULTON.

Philadelphia.

Boring Spherical Bearings.

Editor American Machinist:

Among the early designs of electric generators was one with spherical bearings, as shown in my sketch. The bearings were extra heavy, to stand the pull of the belts. As we had a number of them to make, it seemed expensive to bore by hand feed in a lathe, and it was very difficult to do them in a boring mill with ordinary cutters. The method here shown suggested itself, and was adopted. A strong lathe was selected, and a cast-iron plate was fitted to the bed and bolted fast. On this we clamped the bed and bearings of the generators for boring. The bar designed for the job was of cast iron and fitted with two swivel heads *K*, or tool holders, the right distance apart for the bearings. Into one end of each head *K* was clamped a cutter *H*. The other end was slotted, and a swivel nut was fitted for the feed screw *C*. There were two bearings *B B* fitted to the bar, for each feed screw to run in. On one end of the screw was fitted a star, operated by the bracket *L* bolted to the generator bed. There were collars fitted on the screws to receive the thrust when in service. *D D* are the stars for feeding, and are let into a recess in the bar *A*. This was necessary on account of the feed screw being located so near the bar in order to clear the open end of the bearing *U*.

The arm *K* rotated on a pin *F* in the center of the bar, and was made a good fit, so as to bore a smooth surface, free from chatter, for the bearing. Fig. 2 is an enlarged view of the bar, showing the circular boring device. With this arrangement we were able to bore both bearings at the same time and, with two cuts, to make a true spherical surface in each. By using different lengths of arm *K* we could bore any diameter required.

Sometimes we look at a job of this kind and say, "The designer might have worked out a bearing very much cheaper than that, and would have saved a good deal in special tools." But the shop does not always understand why these designs are made so apparently expensive, and takes the work as it comes to it and suits the tools accordingly.

H. S. BROWN.

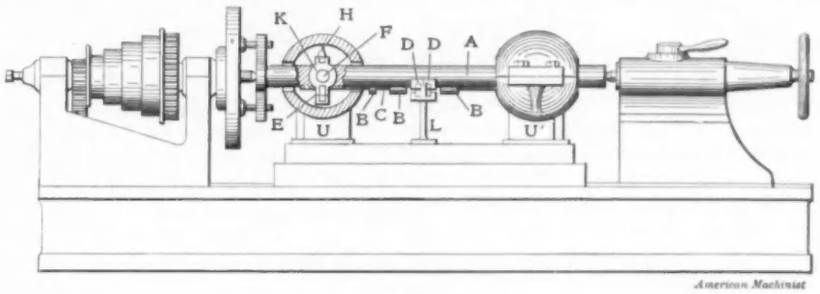


Fig. 1

BORING SPHERICAL BEARINGS.

The Libeled British Workman.

Editor American Machinist:

Upon reading in your issue of August 17 a letter from Morris Fulton, entitled "Automatic Machines and Automatic Men," and his remarks therein concerning the English workman, I have ventured to write you a few lines, which I hope will correct the general impression conveyed in that letter, that we here, as a body, are a slow-moving and dissipated set of men. I certainly think that the writer has, from a mechanical point of view, treated us unfairly, and from a social point with evidently only the slightest personal knowledge.

My experience is, that chiefly it is the employers that want modernizing, and not the workmen. Modern ideas and methods, as a rule, can only be applied to modern machinery. I once worked in a shop where a good class of work was required, and where the chief tools were a few old treadle lathes (this firm had power, by the way) in various stages of decay, and an old sun-and-planet-motion shaper, upon which, even with the lightest cut, one had to give a help around. Yet this firm had plenty of capital, and was eminent in its class of work; but it had got along comfortably so far, and I suppose did not feel justified in making improvements which would benefit both the firm and the workman; and this is typical of a great number of shops here. Where, however, we have modern shops—and I think you will allow us a few—I have found that the workman has entered into it with that spirit and those ideas that go to make a success. I speak from personal knowledge, knowing the many ideas that have come from them which have resulted in the creation of labor-saving devices for the particular class of work upon which they are engaged. The English worker, with the American, recognizes that a vast amount of his work to-day is only due to the possibilities of automatic machinery. I think I may be safe in saying that many of our splendid inventions of to-day would not have been possible, but for the progress in the means of producing machinery. I do not think that the average Britisher is so dull that he does not believe that fact. A man also need not be a hustler, or, as we say here, a tearer, to work a machine to its fullest limit.

As regards the social side of the British, I think your correspondent must have been very unfortunate in his English acquaintances to have selected this dissipated, drinking individual, and then to have practically held him up as a specimen of the British workman. If I thought such to be typical of the nation, I would say with him, "God help the nation." He says, "Of a very different type is the American workman." I suppose by that he would have it that they are all good, and not such as we have here, good and indifferent. I have come in contact with a great number, and have not found one such as he describes. I do not for one minute say there are not such, but I think it unfair for him to take that one instance

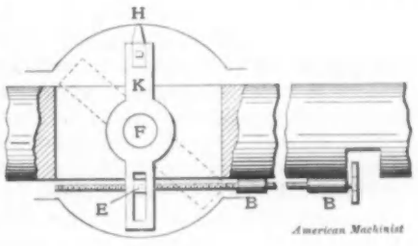


Fig. 2

ENLARGED VIEW OF BORING DEVICE.

and judge. The men here are quite as persevering and as ambitious to get on as our American friends, but they have not the same opportunities.

I trust you will forgive my transgressing on your valuable space, but I did not favor the idea of your countrymen having put before them such a pen picture of an

ENGLISH WORKER.

Fulham, London.

P. S.—I like your paper immensely. This is the first year I have had it, and I shall certainly continue with it now.

The Spectrum for a Color Standard in Hardening.

Editor American Machinist:

It strikes me that I have said once before that the one feature of *our* paper which I enjoy at least as much as any other, is the number of letters from practical men. I do not, of course, mean those especially who have something to say and who are paid for saying it, but those who occasionally have an idea which they think may interest those who would have use for it, and who in communicating it to the "American Machinist" for possible discussion, are well content if they and others learn something.

The discussion in relation to the hardening of steel and the management of the necessary light, by Mr. Hardy, in issue of August 31, was of genuine interest, especially where he remarks that "I believe we will obtain the best results by working always under the same conditions," etc.

He suggests a sheet of colored glass of the proper tint, and as a second choice tissue paper. Personally, I do not like the idea of the tissue paper, especially in the blacksmith shop or hardening room. I have the greatest respect for the knowledge and experience shown by Mr. Hardy's letter, and only express this as a difference of opinion.

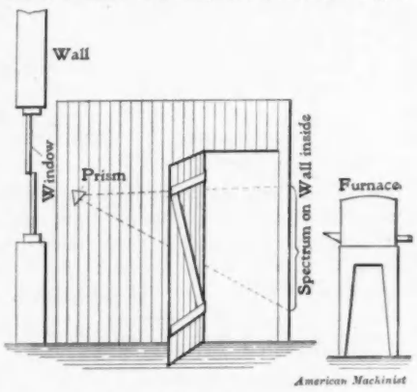
We all understand that in one day the one who does the hardening may have two dozen different degrees of hardness to give to tools, on account of differences in steel, the metal to be worked, the shape of the tools, etc. Suppose then, to obtain a graduation of colors to suit every case, which would be absolutely permanent and always available, we should use the solar spectrum. We would have our "cherry red," or whatever red we found to best suit our case. Every possible color and tint would stand out in its purity and brilliancy for our selection. If a good prism, or, still better, a moderate-priced spectroscope were mounted as suggested in the sketch, we could use sunlight, electric or gas light as necessary. The spectrum would fall on the end wall of the small cupboard. By swinging the door open, and standing behind it in the doorway of the cupboard, the smith could watch the colors of his piece by white light, comparing them as he chose with the spectrum, the darkness of the cupboard giving the necessary contrast for the spectrum and softening the white light to suit the eyes. What do the others think of it?

ROBERT G. PILKINGTON.

Dangerous and Unprofitable Practice With Corliss Valve Gears.

Editor American Machinist:

Although the Corliss valve gear is the acme of simplicity, there are engineers who apparently do not understand its weak points, and consequently Corliss engines are sometimes found in a dangerous condition. I refer to the plan adopted for increasing the speed of the crank shaft where only from three to five additional revolutions per minute are required. If a greater increase than this is wanted, the governor pulley is made larger by wrapping a piece of belt around it, or by making a new and larger pulley, but if only a slight increase in speed is needed, the governor reach rods are lengthened or shortened, as the case may be, in order to give



SPECTRUM GAGE FOR HARDENING.

a later point of cut-off for the same position of governor balls.

Let us note the effect of this. After the builder has determined the position of the balls when running at full speed, the tripping device is set to cut off evenly at the assumed pressure and with an average load, and then the balls are raised until the steam hook is disengaged immediately after it has opened the cut-off valve, so that the charge of steam will not run the engine up to speed even when the main belt is off, and some device is used to prevent said balls from traveling in a higher plane, which is usually a collar set on the spindle so that the center weight strikes it. In the case of an engine with one ecentric and carrying a heavy load, the point of cut-off for the highest possible position of center weight may be a trifle later than this, but it should never be more than just sufficient to run the engine and shafting up to speed, for this is coming very close to the danger line.

Now, for some reason the superintendent wishes to increase the speed of the main line shaft a few turns per minute, and asks the engineer if it can be done without altering the engine. He finds that by changing the length of the reach rods it is possible to increase the speed of the engine three revolutions. As this is sufficient to answer the purpose, the change is made permanent, and nothing more is thought about it until, through failure of the damper regulator to operate or from some other cause, the steam pressure is increased above the ordinary limit, and at the same time a belt that transmits a greater part of the load from the jack shaft to the main line fails, and thus nearly all of the load is thrown off from the engine. The center weight rises as high as the collar will permit, but still the point of cut-off is late enough to run the engine faster than the safe limit, and the flywheel bursts, causing the death of some unfortunate workmen and wounding others, while several thousand dollars' worth of property is destroyed. To the general public the cause of the accident is a great mystery, but not so to those who understand the conditions.

Sometimes an engine is found in this condition when no attempt has been made to increase its speed, for the collar is set lower than it should be, while attempting to prevent the governor from "hunting" and ignorance of the possible results allows it to remain in that position.

Every engine of the Corliss, or any similar, type should be frequently tested for this defect, as follows: With the highest steam pressure on the boiler and the lightest possible load on the engine, force the governor balls to their highest position, and if the speed of the engine is not at once reduced, the valve gear needs immediate attention.

When a valve gear of this kind is new the latches or steam hooks require but little tension on the springs to hold them in place, but after several years of service the corners of the studs or blocks are rounded off by wear so that they will occasionally fail to operate. In such cases it may be proper to give the springs more tension in order to keep the plant running until night, but the practice of adopting this for a permanent remedy should be condemned, for the different parts should be turned until square corners come in contact, and when all are badly worn they should be put on to a grindstone and made as good as new. This will save much of the noise and wear that are so annoying to the careful engineer.

On some of these engines stuffing boxes are used to prevent leakage of steam and water around the valve stems, while on others ground joints on the inside of the steam chest are supposed to do the work of the stuffing boxes with less friction, but they frequently leak, and there appears to be no way to stop it without the aid of the tools and workmen found in a repair shop. Why are these joints made by shrinking, casting or forging square collars on the stems and making flat joints on the inside of the steam chest, instead of

adopting the ball and socket form of joint, which would be much more satisfactory in service? When the outer bearing of a valve stem becomes worn so as to admit of lost motion at this point the square collar is thrown out of perfect contact with the flat surface made for it to partially rotate upon, and a leak is the result, but with the ball and socket design this movement would have no bad effect, especially where the valve is driven by a head upon the stem, the latter projecting but a few inches into the steam chest, and not extending to the bonnet on the opposite side.

W. H. WAKEMAN.

Conclusion of the Franklin Institute Celebration.

The closing meeting of the series held by the Franklin Institute in commemoration of its seventy-fifth anniversary was held on Saturday evening, October 7, in the Convention Hall of the Export Exposition. President Birkinbine briefly outlined the advancement of science and the industrial arts during the life of the Franklin Institute, and introduced Rear Admiral George W. Melville, whose theme was "The Warship, as Combining in Itself the Highest Results of Skill and Ingenuity and Scientific Knowledge."

The paper was confined to a review of the steam vessels of war, beginning with the first of this type in the world, which was designed for the American Navy by Robert Fulton, and proceeding to the modern ships, whose conditions and requirements he discussed quite fully. The admiral spoke in high commendation of Mr. Charles H. Haswell, the first engineer of the United States Navy, who is still living, also of Isherwood, Ericsson and Dahlgreen, as the most prominent names in the development of our navy, the first as the designer of the Wampanoag, a vessel ahead of her time; the second as the inventor of the Monitor, and the third as the originator of the once famous Dahlgreen gun. Besides treating of the construction of the hull, boilers, machinery, guns and armor, to show how thoroughly the adv nce and application of scientific knowledge were exemplified and embodied in the warship, many other details were mentioned, such as the torpedoes, electric installations for lighting various portions of the ships and providing searchlights, workshop on board ship for immediate necessary repairs, watertight doors, pure air by artificial means, the use of distilled water and of steam radiators. The power of the modern guns is such that the force developed at a single discharge of the four principal guns of a battleship would be sufficient to lift the ship bodily fifteen feet, and the rapid fire guns may be worked so fast as to have five shots in the air at the same time.

Dr. Robert H. Thurston, of Cornell University, followed Admiral Melville, his topic being the "Evolution of Technical Education, and the Work of the Franklin Institute." The discourse was chiefly historical, beginning with the remotest ages of which we have knowledge, and showing that technical work and technical instruction were familiar to all historic nations, and probably to the men of the days of Tubal Cain. The work of the Egyptians was specially noted. The steam engine and boiler, the water clock, the apparatus of scientific research, the foundation of mathematics, of physical science, of chemistry and astronomy, of geography and philosophy, the beginnings, in fact, of all learning, were traced back to the Alexandrian and other colleges. Then the course of learning was followed to the Greeks, the Saracens, the Arabians, and thence through Spain to all Europe. A large part of the development of the modern, and especially the American, technical schools had been accomplished during the life of the Franklin Institute, and it had been an important and most efficient worker in the cause.

The paper was read under considerable difficulties, as the exhibition was in full blast, as also was the band in the auditorium, and a very large crowd was distributed through the buildings. A banquet was served at the conclusion of the exercises.

Meeting of the Junior Mechanical Engineers—The Westinghouse Gas Engine.

The first monthly meeting for the year 1899-1900 of the members of the American Society of Mechanical Engineers, under the impulse and the management of the junior members of the society, which was held at the house of the society on October 3, was a most gratifying success, being interesting, enjoyable and profitable. Mr. Henry E. Longwell gave a very complete account of the Westinghouse gas engine, its development and the details of its design and construction.

In some introductory remarks, which were appreciated and applauded, and which elicited several smiles of various sizes, Mr. Longwell alluded to the fact that the gas engine, like all the other prominent so-called inventions, is a growth, or the product of a process of development. We are too apt to dub as inventor the man who merely places the keystone and completes the arch which has been long in the building. Stephenson is said to have invented the locomotive, but he merely officiated at the wedding of the steam engine and the wagon. So was it also even with Watt and the steam engine. Once upon a time, long years before Watt, some fellows were having a good time, and an emptied wine flask having rolled near the fire and got hot, it was picked up and the neck of it dipped in water, when the cooling of the contents was followed by the rising of the water in the flask, and the idea of the condenser was caught. Although cold water plays such an important part in the operation of the condenser, if all the world had been drinkers of cold water this one of its many important mechanical functions we might still have to discover.

Distinctly so has it been with the gas engine. Some sketch of the European development of the gas engine was given, and then allusion was made to the studying and experimenting out of which the Westinghouse gas engine has grown. Although it has been before the public but three years, voluminous records and numerous drawings attest the labors of ten years preceding, and improvement still goes on.

Such as the above by way of introduction. The larger portion of the speaker's time was then given to informal comment and explanation of the principles of operation and the details of construction of the Westinghouse gas engine as illustrated by numerous lantern slides. The most prominent improvement embodied in the engine is in the mode of governing, whereby the speed is made practically as uniform as that of a well governed steam engine, while a gas engine of the hit-or-miss type is at best only the equivalent of a "racing" steam engine, or it maintains a mean speed by the alternation of excesses above and below it. Photographs of various engines were shown, concluding with one of 600 brake horse-power, and a drawing was shown also of a three-cylinder engine of 1,500 horse-power. While it has been the impression that the gas engine is only for the smaller units of power, the speaker said that there were no indications of any unconquerable difficulties to be overcome in building and operating much larger engines than any yet thought of.

The discussion which followed was entirely conversational in form, and consisted rather of questions from those present, which the speaker freely and fully answered, thus contributing much additional information upon the subject. The noise of the gas engine was spoken of, and Mr. Longwell said that this objection belonged to the hit-or-miss style of engine, while the exhaust of the Westinghouse engine is constant and uniform as that of a steam engine, and is unobjectionable. A speaker told of his experience in New York city in trying to get rid of the noise of the gas engine, which was objected to by the Board of Health, and described various ineffective devices which he had tried, but finally spoke of one which was entirely successful. The engines with which he had been experimenting were those, usually small, employed for pumping water in tenement houses. The exhaust from these engines is carried to the roof, and the simple device which killed the noise was the use of a long pipe with

a cap on the end and a very narrow slit running the whole length of it.

Those who attended the meeting seemed to be unanimous in pronouncing it a success.

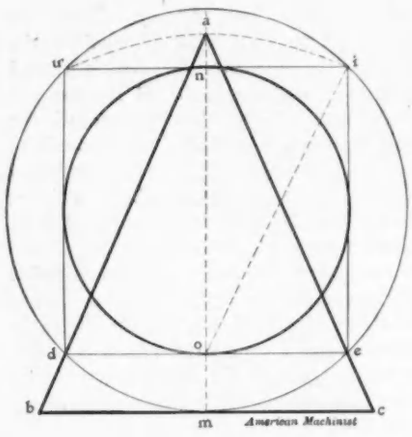
Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer by mail.

(90) J. J. M., Schenectady, N. Y., sends a sketch of a hand lever test pump and asks: (1) Will a change in the diameter of the outlet, without changing the diameter of the ram, alter the capacity of the pump? A.—No. (2) How is the capacity of such a pump calculated? A.—Measure the distances from the fulcrum to the ram connection and to the center of the handle. Divide the latter by the former and multiply the result by the pounds of effort applied to the handle. The result will be the total pressure applied to the ram. Divide this by the number of square inches in the cross section of the ram, and the result will be the theoretical pressure per square inch produced by the pump, which will be slightly greater than the real pressure on account of friction of stuffing box, etc.

(91) J. D., Streator, Ill., says: (1) A friend of mine claims that in some parts of the sea the depth, and consequently the pressure, is so great that an iron body, such as an ironclad or a cable, would go down a certain distance and there remain stationary. Is this so? A.—No. The question of sinking or floating of a body in water is one of the comparative or specific weights of the body and water, and has nothing to do with the pressure. If the body weighs less per cubic foot than water it will float; if more, it will sink, and if it sinks at all it will go to the bottom, no matter how deep the water may be. (2) Can you give me a formula to find the necessary pressure for compression in the top and bottom of a vertical engine cylinder? A.—More cushion is needed at the lower end of a vertical engine cylinder than at the upper, but it is obtained by varying the lead and not the compression. With slide valves the compression could not be changed without altering the release, and could only be changed at all by altering the valve, whereas the lead can be adjusted back and forth indefinitely until quiet running is obtained. We do not think there is any rule or formula for the case, which is rather one of experience and of cutting and trying.

(92) J. C., Brockton, Mass., writes: I cut the inclosed figure from the "London Engineer." It was sent in by a correspondent in Australia, who believes it to be a wonderful discovery in mathematics. He claims that the area of a triangle is equal to that of the circle, and proved it by cutting out each figure in drawing paper and weighing them in gold scales, where they balanced. Cannot this be more certainly demonstrated by computation? A.—The operation is not difficult. Let the diameter of the circle and the side of the square be 1. Then the area of the circle will be .7854, and the area of the triangle is asserted to be the same. The diameter of the larger circle will be $\sqrt{2} = 1.4142$. The radial distance between the outer and the inner circumference will then be $\frac{.4142}{2} = .2071$. The length of $a\ c$ will be $1 + .2071 = 1.2071$, and the length of $a\ d$ will be 1.4142. The length of $o\ u$ will



be $a\ c : a\ d :: e\ i : o\ u$, or 1.2071 : 1.4142 :: 1 : 1.1715 +. The area of the triangle will then be $\frac{a\ d \times o\ u}{2}$, or $1.4142 \times 1.1715 \div 2 = .8283$, or more than 5 per cent. greater than the area of the circle.

(93) L. W., Philadelphia, asks: (1) What is the most accurate way to cut double or triple screw threads in the lathe, so that the threads will be of the same thickness? A.—There are several ways to do this correctly, each of them therefore as "accurate" as any other. If a double male thread is being cut on the centers, the work being driven by a dog with a tail in a slotted face-plate, when one thread is cut the center may be slackened and the work shifted halfway around, bringing the tail of the dog in the opposite slot of the face-plate. It must be ascertained that the slots are laid out correctly. If the work is driven by a stud in the face-plate against a tailless dog, two studs in the face-plate may be placed opposite each other and the work shifted so as to drive by one stud and then by the other. So, too, for triple threads three equally spaced slots in a face-plate or three studs may be used. In all the operations here referred to it is understood that the lathe is not in motion when the changes are made. In cutting either male or female threads they may be in many cases cut double or triple by unlocking the nut on the feed-screw, moving the rest along and closing it upon another thread. Thus if the pitch of a double thread to be cut is an odd number to the inch, while the pitch of the lead screw is an even number to the inch, it is only necessary when one thread is cut, or partially cut, to open the nut, move the rest along half an inch and then close it again to bring the tool in position for cutting the other thread. Thus, if a double thread with a pitch of 5 to the inch is to be cut, while the lead screw is 4 to the inch, it is only necessary to keep moving the rest along two threads at a time on the lead screw, and the change of cut is made from one thread to the other on the work. This applies also to any other common unit of measure for the two threads. If the pitch of a double thread to be cut is 6 to the inch, while the pitch of the lead screw is 4 to the inch, then for each half inch one will be odd and the other even, and a 6-pitch double thread may be cut by successively moving the rest along a single thread on the lead screw. If the pitch of the lead screw is 3 or 6 to the inch, triple threads may be cut to any pitch, except 3 to the inch or multiples of 3, by successively opening the nut and moving the carriage along a third of an inch and then closing the nut again. Other opportunities in this line will occur to the latheman who is at all expert at arithmetic. But the common practice in cutting double or triple threads, and which covers all cases, is to throw the train of screw-cutting gears out of mesh, move the lathe spindle around a half or a third of a turn, as the case may require, and then put the gears in mesh again. To do this accurately it is usually necessary to count the teeth of the driving gear, and for double threads this gear must therefore have an even number of teeth, for triple threads a number divisible by three, and so on. Having, say, thirty teeth in the driving gear, the lathe being stopped, a tooth of the driving gear and the space into which it meshes in the intermediate gear are marked with chalk, also the opposite tooth on the driving gear. The intermediate gear is dropped out of mesh with the driver, remaining still in mesh with the screw; the lathe spindle is turned halfway around, bringing the other marked tooth in the required position to mesh into the marked space in the intermediate gear, which is then brought into mesh and secured, when all is ready for cutting the other thread. The driving gear in this case was moved along fifteen teeth. In cutting a triple thread it would have been moved along only ten teeth at a time. If the driving gear is on a stud which runs at one-half the speed of the lathe spindle, then for cutting double threads, the driver must make a complete revolution out of mesh and the same tooth be then brought to mesh in the same space. For triple threads it would make two-thirds of a revolution at a time, and so on. In making the changes it will make no difference in which direction the spindle is turned. The pitch of double or triple threads is the distance the nut will traverse the

screw for a complete revolution multiplied by the number of times this distance is repeated in an inch of travel. (2) In cutting milling cutters, how is the diameter divided to bring the cutting teeth out right at the last tooth. A.—The diameter has nothing to do with it. The indexing head rotates the cutter the exact proportion of the complete rotation that is required according to the number of teeth to be cut. The last tooth will be of the same width as the rest, and after the last tooth is cut the next movement brings the cutter into the position for cutting the first tooth again.

Personal.

Mr. Hugo Noot, of Vienna, Austria, who is a large iron and steel manufacturer, is visiting this country.

Prof. W. S. Aldrich, formerly professor of mechanical engineering at the University of West Virginia, has been appointed professor of electrical engineering at the University of Illinois, Champaign, Ill.

Mr. George R. Dunell, an engineer of London, who has been a contributor to the technical press, both British and American, is here for the purpose of studying industrial matters and reporting for the London "Times."

Mr. C. J. Field, who was recently connected with the American Vitrified Conduit Company, has taken the position of vice-president and general manager of the United States Motor Vehicle Company, Townsend Building, New York city.

Mr. P. J. Darlington, until recently superintendent of the Royal Electric Company's shop at Montreal, Canada, was recently presented by the employees, as a token of esteem and regret at his departure, with a gold watch and chain suitably inscribed.

Messrs. Loewe and Orcutt, of the firm of Ludw. Loewe & Co., Berlin, Germany, arrived here on the 3d inst., and will spend about a month in this country, looking through some of our shops and investigating mechanical and engineering matters. Mr. Loewe comes as chairman of a delegation to the Commercial Congress to be held in Philadelphia, his associates being Messrs. Arnhold and Goldschmidt, and the delegation represents the Aeltestender Kaufmannschaft, of Berlin, to the Commercial Congress of Philadelphia.

The Growth of the Krupp Works.

A book recently published in Germany gives an account of the establishment, the growth and the present magnitude of the Krupp Works at Essen, a story of the most remarkable industrial development ever accomplished. The grandfather of the present Krupp started an iron foundry in 1810. For sixteen years he barely made a living. In 1826 his son, Alfred, succeeded to the struggles of his father. In 1832 he had only nine men in his employ. He, however, was making good steel and good guns. His steel and one or two guns were in the great London Exhibition of 1851, and this brought him instant recognition. He was talked of then as the great steel maker. Large orders from various governments began to pour in. His first large commissions were, rather strangely, from the Khedive of Egypt and the Bey of Tunis, and his best customer has been Russia, to whom he has sold 30,000 guns.

It is useless to try to follow the rapid growth of the business. There are processes in the Krupp manufacture that are not yet known to the trade, and they are carried on in buildings that no visitor is permitted to enter, or even the employees from other departments. The establishment, by rapidly securing its own mines, has made itself independent of rings and syndicates, and by its accumulations of stock equally regardless of market fluctuations.

The figures concerning the business at the present time are interesting. On January 1 of the present year there were on the pay-rolls 41,750 men, of whom over 25,000 were employed in the works at Essen. In 1895 there were in the steel works at Essen over 3,000 implements and machines and 458 steam engines, aggregating 36,561 horse-power. There are over 40 miles of leather belting. In the statistical year 1895-96 over 1,000,000 tons of coal and coke were consumed. The consumption of water is equal to that of Dresden with its population of 336,000, and more illuminating gas is used than in that city. There are 50 miles of railroad track on the premises, with 36 locomotives and 1,300 freight cars. There are 522 telephones.

Our Workmen.

The New York "Tribune" declares it to be "perfectly true" that our workmen do "too much for the pay and too little for the work's sake," and further, that "an alarming proportion of our labor is half heartedly performed or dishonestly

(*Continued on page 40.*)

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant ; see p. 16.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Forming lathes. Mer.Mach.T.Co.,Meriden,Ct.

Punches & dies. Wal.M.Wks.,Waltham,Mass.

Rawhide, fibre and hard rubber gears. The Arthur Co. (See page 8.)

Construction and repair of Commutators, 50c. L. C. Sharp, Omaha, Neb.

Fountain blueprint brush mailed, $2. Edw. A. Osse, 134 S. Charles st., Baltimore, Md.

Light and fine mach'y to order ; models and elec. work specialty. E. O. Chase, Newark, N. J.

Book "Dies and Diemaking," $1, post paid. J.L.Lucas,Bridgeport,Ct. Send for index sheet.

"Brandt's Triple Expansion Gaskets" are the best for boilers. Randolph Brandt, 38 Cortlandt st., New York.

Wanted—Bound volumes of "American Machinist," years 1895, 1896 and 1897. Le Blond Mach. Tool Co., Cincinnati, Ohio.

For Sale, Cheap—First-class patterns for gasoline engines, also working drawings for automobiles. Address Box 331, AMER. MACH.

Anyone who desires to manufacture a profitable machine tool, which is selling more rapidly than it can now be produced, should communicate at once with Box 332, AMERICAN MACHINIST.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

Correspondence is desired with responsible and competent parties who will join the advertiser in the lease or purchase and management of large machine shop ; now employing 200 men and doing profitable business ; equipment nearly new. Address "High Speed," care AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded ; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents.

Situations Wanted.

Situation as foundry foreman by an experienced foundryman ; best reference. Box 326, AMERICAN MACHINIST.

An experienced foreman on engines and general machine shop work desires position. Box 314, AMERICAN MACHINIST.

Mechanical engineer, member of A. S. M. E., with 10 years' practical experience, wants position. Box 294, AMERICAN MACHINIST.

Desire good position in the city ; am experienced draftsman ; graduated in Europe ; well up in languages. Box 327, AM. MACH.

Situation wanted, by an experienced superintendent or general manager for machine shop. Address "Stanley," care AMER. MACH.

Wanted—Position as superintendent ; experienced in manufacture of machine tools ; have a record of success. Box 320, AMERICAN MACHINIST.

Party with machine shop and drafting room, general supervision of details and management of labor, desires a situation. Box 1429, Boston, Mass.

Wanted—Position by mechanical draftsman, experienced in electrical and general machinery ; first-class references. Box 328, AMERICAN MACHINIST.

Experienced marine engineer desires work which can be done outside office hours ; specifications, plans and inspection. Box 322, AMERICAN MACHINIST.

Wanted—Position as superintendent ; 15 years' experience in gas and gasoline engines ; first-class draftsman and designer for automobiles. Address Box 330, AMER. MACH.

Draftsman, able to design and build gas and gasoline engines, wants position with concern desiring to build gas engines, either as draftsman or superintendent. Box 324, AMERICAN MACHINIST.

A successful mechanical superintendent is open to an engagement ; a first-class manager, up in modern shop practice and economical production of work ; correct habits and reliable. Box 329, AMERICAN MACHINIST.

Chief draftsman, with extended experience in designing and estimating cost of large steam engines and pumping machinery, desires change of location ; best references from present employers. Box 325, AMER. MACH.

Mechanical engineer (28), some shop experience, successful superintendent 4 years factory in chemical line, now under contract to keep out of that branch, desires opening with engineering or manufacturing concern ; moderate expectations. Box 321, AM. MACH.

(*Continued on page 40.*)

(*Continued from page 39.*)

skimped. In Europe, with all its needy and mercenary workmen, it is easier to get a simple task faithfully performed from mere pride, or perhaps from the habit of doing work well."

This is the deliberately expressed opinion of a leading American newspaper, not that of an alien journal, expressing the general foreign alarm of the dangerous competition in the markets of the Old World of the production of American workmen. It is one of the gravest arraignments of the representatives of labor in this country which has ever been made by a respectable authority either at home or abroad, and it is of the first importance, if it is true. The "Ledger" does not believe it to be true, and assumes to speak with some little authority on the subject, as there are in its employ, as there have been since the year 1836, a large number of workmen. In its various labor departments there are from 100 to 200 employees, and it has never had cause to believe that they have done too much for pay and too little for work's sake, or that an alarming, or an unalarming, proportion of them has performed its work in a half-hearted manner; much less is it true that its employees have "dishonestly skimped" their work. In fact, the actual experience of the "Ledger" respecting this matter is that, under certain conditions of severe test, the "Ledger's" workmen have exhibited not only the highest perception of fidelity to their employer, but a manly pride in their work, which cannot be too highly commended.

But the "Ledger" employs a comparatively small number of mechanical workmen, mere hundreds. The Cramp Shipbuilding Company employ a comparatively large number of workmen, several thousands. Mr. Charles H. Cramp, the head of that corporation, bears the following testimony to the integrity and skill of the American workman, in his valuable paper on "The First Cost of Ships."

"Put the plans and specifications of the average English tramp (steamship) in the hands of an American shipbuilder, and he could not duplicate her. He would build a better vessel, of superior workmanship and neater finish in every respect; for the reason, to put it broadly, that the mechanics who make up an American shipyard organization are trained to a grade of performance which they could not reduce to the standard of tramp construction."

As to the alleged superiority of the foreign workman, his fidelity to and pride in doing the best work, upon which the "Tribune" insists, it does not appear to exist. Certainly it is not in evidence in England. In that country they do not designate imperfect workmanship as "skimped," but as "scamped," and there is more scamping done by the British

(*Continued on page 41.*)

Situations Wanted—Cont'd.

Young man, machinist, technical graduate and teacher 4 years of pattern-making, foundry practice, forge and machine shop practice in a Tech., wants position in business; has had charge of tech. shops 2 years; best of references and character. Address Box 319, AMERICAN MACHINIST.

Wanted—Position as superintendent, by an American, who is a thorough mechanic and prefers high-class automatic machinery; I now hold position of superintendent, and can furnish highest reference as to ability and character by present employers. Address Box 323, AMERICAN MACHINIST.

Help Wanted.

Wanted—Metal pattern maker; apply by letter, giving experience. Box 337, AM. MACH.

Wanted—An experienced designer on jig and tool work. Box 338, AMER. MACHINIST.

Wanted—An efficient machinist to take charge of gang in machine tool shop. Box 339, AMERICAN MACHINIST.

Wanted—First-class man as assistant layer-out; state wages and references. Address "Layer-out," care AMERICAN MACHINIST.

Wanted—A draftsman who has had experience on turret and engine lathe design; good pay for the right man. Box 334, AMERICAN MACHINIST.

Machinists wanted; a number of first-class men on high-speed marine engine work. Apply Gas Engine & Power Co. and Charles L. Seabury & Co., Consolidated, Morris Heights, New York City.

Wanted—Experienced draftsman to work on cotton machinery; good position for an A1 man; state experience, references and salary expected. Address Box 317, AMERICAN MACHINIST.

Wanted—In our automatic screw-machine department of 18 machines, one working second hand and one operator on the Hartford and Cleveland machines. McKay Metallic Fast. Assn., Winchester, Mass.

Wanted—An up-to-date foreman machinist familiar with flour-mill and transmission machinery, working about 15 men; state experience, where heretofore employed and wages expected. Box 336, AMERICAN MACHINIST.

Wanted—Machinist foreman for college shops; foundry experience desirable; 400 students, 30 apprentices; machinery and scientific apparatus built; salary $900 per year. Address Mechanical Dept., Kansas State College, Manhattan, Kansas.

Draftsman wanted; must be a competent man, familiar with modern machine-shop practice and capable of general machine designing, under instruction; a permanent position is open to the right party. Address Box 316, AMERICAN MACHINIST.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite applications from draftsmen, pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Wanted—In a large Ohio River city, a foundry foreman in a first-class shop working about 10 men on special machine castings and flour-mill machinery; state experience, where heretofore employed and wages expected. Box 335, AMERICAN MACHINIST.

Wanted—Superintendent, capable and energetic man, thoroughly experienced in factory practice; knowledge of the principles of electricity desirable, but not essential. Address "Manufacturer," care AMERICAN MACHINIST, stating experience, age, references and salary expected.

Wanted—A competent master mechanic and foreman now holding or having lately held such position with establishment of recognized standing, who is desirous of improving his opportunities, in a large, newly equipped shop manufacturing a light machinery of high quality with interchangeable parts and including type-mold work; applications will be confidential, but to receive consideration must be full, giving name of former employers, with exact position and number of men under applicant's direct authority; also state salary expected. Address Box 333, AMERICAN MACHINIST.

DRAUGHTSMEN WANTED on Mill Machinery and Machine Tools.

APPLY TO

BETHLEHEM STEEL COMPANY, South Bethlehem, Pa.

Civil Service Examinations, State of New York.

Open competitive examinations will be held November 4, 1899, in various cities throughout the State for positions mentioned below; candidates having applications on file will be given ten days' notice of the time and place of examination most convenient to their places of residence.

Intending competitors must file applications in the office of the Commission on or before October 30. No one will be admitted to examination without the official notice (form 8) from the Chief Examiner of the Commission.

Applicants must be at least 21 years of age and residents and citizens of New York State. Time allowed for each examination, six hours.

Examiner, State Civil Service Commission, requiring a knowledge of steam, electrical and mechanical engineering; salary, $1,200 to $1,400 per annum.

Foreman of Furniture Finishing, Auburn and Sing Sing Prisons; salary, $2.50 per day.

Master of Handicraft, State School for the Blind, Batavia; salary, $50.00 per month and maintenance.

For application blank and detailed circular, address STATE CIVIL SERVICE COMMISSION, Albany, N.Y.

A Valuable Volume.

Everyone who is in any way interested in Mechanics will find it to their advantage to immediately procure the new book entitled,

MECHANICAL MOVEMENTS,

Powers, Devices and Appliances.

By Gardner D. Hiscox, M. E.

Over 400 pages. Large octavo. 1649 specially made illustrations, with full descriptive text.

PRICE, $3.00.

This work is practically a complete mechanical education, commencing, as it does, with a rudimentary description of the first known mechanical powers, and gradually tracing up the history of mechanics and appliances to the present day.

It fully illustrates the leading devices for the transmission of power and its measurement. It exhaustively describes every known motive power in the world, deals with the principles of construction in electrical appliances, treats of the horseless carriage and bicycle movements, minutely describes every known kind of machine, both large and small, gives their various uses and method of construction, and, in short, presents a copious dissertation on mechanics, powers, devices and appliances.

It is a book which every machinist, inventor, student, mechanic, draughtsman, engineer, electrician, and everybody interested in the devising and operation of mechanical works, should have in his possession. As a handy book of reference it is without a peer.

A special illustrated circular mailed on application, or the book prepaid to any address in the world on receipt of price.

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Sold at all Machinists' Supply Stores.

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GEARS of all descriptions

"Better Looking Oil Than We Buy."

ROCKVILLE, Conn, July 23, 1896.

The Burt Mfg. Co., Akron, O.

We are very much pleased with the filter purchased from you some time ago. It gives us perfect satisfaction, and gives in return a better looking oil than we buy.

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30 Days' Trial Free. Largest Manufacturers of Oil Filters in the World.

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NICHOLSON FILE CO.,

PROVIDENCE, R. I., U.S.A.

SAM'L M. NICHOLSON, Pres. and Gen. Mgr. Largest Makers in the World.

(*Continued from page 40.*)

workman than is dreamed of by his American competitor. To-day the productions of the latter's skill, his honesty and fidelity to the best ideals are sharply crowding the productions of the workmen of both Europe and Asia. The superior workmanship of American workmen is asserting and demonstrating itself in every industrial market in the Old World. The distressing cry of the British manufacturer is no longer that the competing article is "made in Germany," but that it is "made in America." The value of our manufactured exports grows by leaps and bounds, and because American workmen are not only physically but morally superior to those of foreign countries. They do their work not only with rare skill, but in good conscience, with fine integrity and a high perception of loyalty to themselves, to their work and to their employers. Their success in both the home and alien markets refutes the accusation of the "Tribune" that they do "too much for the pay and too little for the work's sake;" that "an alarming proportion of their labor is half-heartedly performed or dishonestly skimped." The very reverse of this is indisputably true.—Philadelphia "Ledger."

Saturday evening, September 23, a farewell banquet was given by leading citizens of Hamilton, Ohio, to Col. Robert C. McKinney, on the occasion of his leaving Hamilton to assume his new duties at the head of the Niles-Bement-Pond Machine Tool Company. A gold loving cup was presented to the guest of the evening, and the remarks made by the various speakers showed very clearly that Col. McKinney has not, during his residence in Hamilton, been so much engrossed in his own business affairs as to prevent him earning the proud title of a good and public-spirited citizen. One speaker, who had been a co-laborer with him in public work, declared that he had known Mr. McKinney to give "time and money for the public good when his own private interests were being antagonized. This," he truly declared, "was a test of the highest citizenship."

The power for the new works of the Pennsylvania Malleable Company, about to be erected at Pittsburgh, is to be supplied by gas engines exclusively. Contracts have been placed for six Otto gas engines of 65 horse-power each, with options on four more. The engines are all to be located in one power house, electric transmission being employed throughout. The main building is to be 640x220 feet, with a number of others of smaller dimensions.

In a recent appeal which reached the German Supreme Court, a verdict was rendered from which it appears that the theft of electricity is not punishable by

law. In the case referred to, the court held that those properties are wanting in electricity necessary to constitute it a movable object in the sense of the law, and electricity must be reckoned as one of the energies of nature, like light, heat and sound. With all due respect to the German court, we feel impelled to say that the decision is not in accordance with common sense. That which men have produced by the employment of capital and the expenditure of labor belongs of right to them as producers, and he who steals electric energy is as much a thief as he who steals any other thing produced by human labor.

Manufacturers.

The Cohoes (N. Y.) Foundry & Machine Company has recently made an addition to its plant.

The Hill Clutch Company, of Cleveland, Ohio, has commenced work on an addition to its plant.

An addition will soon be built to the Amsterdam (N. Y.) silk mill. It will add 100 to the 125 now employed in the mill.

The Portland Rolling Mills Company's works at Portland, Me., were recently destroyed by fire, entailing a loss of $75,000.

Work has been commenced in earnest on the erection of the steel plant at the Brown Bonnell Works of the Republic Iron & Steel Company, Youngstown, Ohio.

Philip Wunderle has signed a contract with Harry Bracklehurst to build third and fourth-story additions to his factory in the rear of 16 Pegg street, Philadelphia, Pa.

The Union Casting Company, Pittsburgh, Pa., has been compelled to increase the size of its plant. The foundry is a new concern, having been in operation but a month.

J. W. Cregar, the Bourse, Philadelphia, has brought out a new center grinding machine, which is attached to the tool block and derives its motion from the lathe face plate.

The North & Judd Manufacturing Company, of New Britain, Conn., manufacturers of light and medium castings of every description, is making an addition to its foundry.

At Bridgeport, Conn., the Benedict & McFarlane Company, contemplates leasing the old plant of the Benham & Hawley Company and starting a factory employing about 150.

The United States Motor Vehicle Company was recently incorporated under the laws of New Jersey, and has opened offices in the Townsend Building, Twenty-fifth and Broadway, New York City.

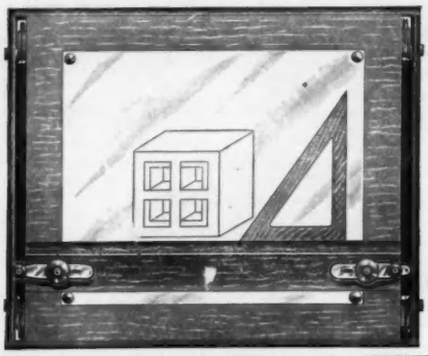
The Hoepfner Refining Company, of Hamilton, Ont., has awarded the contracts for the erection of its main building, which will cost $30,000. The work will be proceeded with at once.

Bids were opened recently for the contract for the erection of the new four-story factory buiding to be erected at West Ninth and Mulberry streets, Des Moines, Ia., by the L. J. Wells Company.

Swift & Co. recently broke ground for the erection of a soap factory, 128 by 173 feet, near Loomis and Forty-second streets, Chicago. The plant will cost $60,000 and give employment to about 200.

The Reading Railroad Company broke ground recently for its new repair shop, opposite the present car-shop building, in Reading, Pa. The building will be pushed toward completion as rapidly as possible.

(*Continued on page* 43.)



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is as essential in the drafting room as in the machine shop. Why not? This parallel rule attachment to a drawing board—replacing the T-square—saves time, increases accuracy, and brings the drafting room equipment up to date like other parts of your shop if you are progressive—and of course you are.

LEIGHTON & WISNER, Mfrs.
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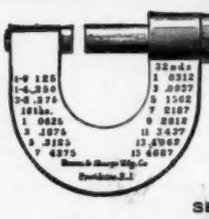
BALDWIN, DAVIDSON & WIGHT,
25 Grant Pl., Washington, D. C. 141 Broadway, New York.

We Like to Figure

on the making of special tools and fixtures. Some people can make lower figures, but not on the same quality of work.

Grant Mfg. Co., Bridgeport, Conn.



TOOLS FOR MACHINISTS

The Brown & Sharpe No. 8 Micrometer Caliper with Ratchet Attachment.

SEND FOR OUR CATALOG OF MACHINISTS' TOOLS.

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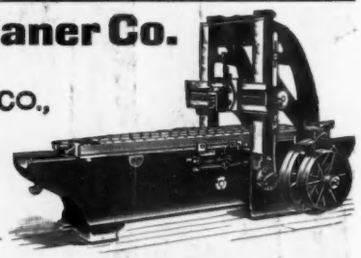
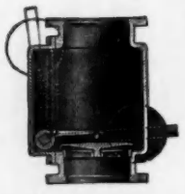


U. Baird Machinery Co., 125 Water St., Pittsburgh, Pa.
Robinson & Cary Co., St. Paul, Minn.
W. R. Colcord Mchy. Co., 502 North 2d St., St. Louis, Mo.
Parke & Lacy Co., Fremont St., San Francisco, Cal.
The Fairbanks Co., 705 Arch St., Philadelphia, Pa.



Excelsior Straight-Way Back Pressure Valve.

This valve has no dash pots, springs, guides or complicated levers to get out of order. It is simple, reliable and well made. Never sticks, and can be relied upon at all times when using exhaust steam for heating; or when used as a relief, or free exhaust on a condensing plant, it has no equal. It is noiseless and free from any complicated attachments.

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A Text Book for Manual-Training Schools. By MANSFIELD MERRIMAN.
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LONG-LIVED GRINDING WHEELS

are money saving wheels. A Carborundum wheel will grind much more than an emery wheel before becoming useless.

CARBORUNDUM

wheels last longer than emery wheels because the extreme hardness of the material enables us to use hydraulic pressure in forming them, which makes them much more solid and stronger than a porous, loosely-constructed emery wheel in which the grains are much softer.

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